

# ROADS and STREETS

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## BASE STABILIZATION WITH PORTLAND CEMENT

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THE literature on soil hardening by means of Portland cement is limited as compared with that on other methods of soil stabilization. Therefore, test data obtained and construction methods employed in this type of stabilization deserve being collected and presented to the road building industry in order to make the experience gained available to those interested. In this way it may be possible to forestall costly and unnecessary duplication of development details encountered in the application of any new construction method.

For this reason a soil-cement stabilization project 4.438 miles long which was recently completed on Route 46, Nodaway County, Missouri, is described in this article. The outstanding feature in the construction of this project was the successful use of a gang plow in conjunction with offset disk harrows for preparing the road-bed material and in the cement processing operations.

The type of soil encountered, the tests which are a basis for the adopted design, the features of importance in the preparation of the roadbed, the different operations incidental to cement processing, such as application of cement, dry and moist mixing, compacting and finishing are described in sufficient detail to allow an understanding of the main factors involved in the actual construction of such a project.

The soil-cement stabilization project described was the fourth to be constructed by the Missouri State Highway Department and the second to be constructed in this state under contract. The work progressed smoothly with good organization in personnel, and construction procedure.

### The Soil

A rather detailed description of the soil encountered on this project should be of interest as the character of the soil is an important factor influencing not only the quantity of cement necessary to impart the desired hardening and durability but also the amount of work required for satisfactory cement processing.

In general, the soil occupying the area traversed by this road is derived from a mature loessial deposit underlain at rather shallow depths by soil of glacial origin.

Weathering forces have developed three distinct soil layers in the loessial profile, differing to a marked degree in both texture and physical properties. See Table I. By referring to this table it is apparent that the liquid limit, plastic index and clay content increases in each successive layer from the surface downward.

The topography is moderately rolling and, as would be expected, the grade line over a considerable portion

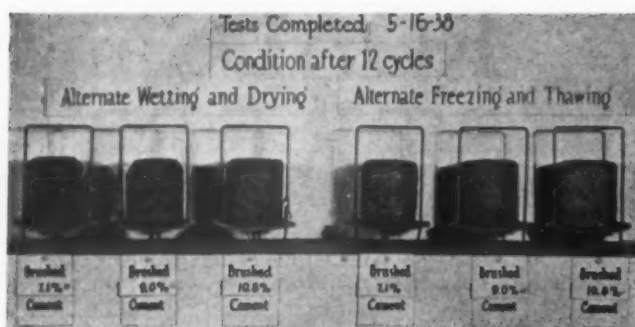
TABLE I—TEST RESULTS ON TYPICAL SOIL PROFILE SAMPLES—MATERIAL PASSING No. 40 SIEVE

Origin	Layer	Average Thickness, Ins.	— Physical Properties —							VME
			LLL	LPL	PI	Vol. Ch. @ FME	SH. LIM.	SH Ratio	FME	
Loessial	Surface	0 to 15	48.3	32.8	15.5	41.1	18.6	1.78	41.7	30.7
Loessial	Sub-surface	15 to 32	49.9	26.9	23.0	35.5	15.5	1.85	34.7	29.9
Loessial	Sub-soil	32 +	55.6	27.7	27.9	40.4	13.0	1.87	34.6	30.0
*Glacial	Sub-soil	.....	60.7	29.0	31.7	49.3	11.9	1.98	36.0	37.6

Origin	Layer	— Mechanical Analysis —				Textural Class
		Pct. Sand 1.0 to .05 mm.	Pct. Silt .05 to .005 mm.	Pct. Clay Smaller than .005 mm.	Pct. Colloids Smaller than .001 mm.	
Loessial	Surface	17.0	67.0	16.0	7.0	Silt loam
Loessial	Sub-surface	15.0	61.0	24.0	11.00	Silty clay loam
Loessial	Sub-soil	11.0	56.0	33.0	19.0	Silty clay
*Glacial	Sub-soil	20.0	37.0	43.0	19.0	Clay

\*This soil is an exceedingly tenacious clay.



—By Courtesy Portland Cement Association  
Durability Tests

of the project consists of a series of rather short alternate cut and fill sections. As a result soil from each of the three soil layers included in the loessial profile was encountered in some portion of the roadbed on a majority of the sections processed.

The glacial subsoil layer which is a very tenacious clay, was only encountered in the roadbed on two short stretches, each approximately 200 feet in length. However, it can be concluded from the additional work required to satisfactorily pulverize the roadbed on these two stretches, that if this soil layer had been encountered in greater amount, the time required for preparing the roadbed per mile (28 hours) as shown in Table VI would have been considerably longer.

The existing road surfacing was a mixture of crusher-run limestone and soil, averaging one inch in compacted thickness. Texturally the roadbed material to a depth of 6 in. was a clay loam. (See Table II.)

### Sampling and Testing

A reconnaissance survey was made and roadbed samples weighing about 200 lbs. each representative of the various soil layers encountered were obtained to a depth of 6 in. These samples were forwarded to the Missouri State Highway Department Materials Laboratory, where moisture density and durability tests were made with varying cement contents. These tests were made in accordance with the procedure recommended by the Development Department of the Portland Cement Association. An additional sample representative of the more unfavorable soil\* was obtained by representatives of the Portland Cement Association and forwarded to their laboratory at Chicago for tests.

The results of tests made in the Missouri Highway Department Laboratory indicated that satisfactory hardening and durability could be obtained with the more unfavorable soil by the addition of 9 per cent cement by volume of compacted roadway.

The Portland Cement Association recommendations based on the results of tests on the sample forwarded to their laboratory are as follows:

"Test data for this soil show that it can be hardened by the addition of Portland cement to produce a desirable weather-resistant roadway. Although test data indicate that a cement content of 8 per cent by volume of compacted roadway would, under normal circumstances, result in a product of suitable durability, it is recommended that a cement content of 10 per cent by volume of compacted roadway be used on this project in order to provide for possible construction variables."

Table Number III contains density and durability test data furnished by the Portland Cement Association:

\*This is the subsoil layer of the loessial profile.

TABLE II—MECHANICAL ANALYSIS, PHYSICAL TEST CONSTANTS, OPTIMUM MOISTURE AND MAXIMUM DENSITY SIX-INCH THICKNESS OF ROADBED MATERIAL

	Laboratory Numbers—			
	38-1093	38-1094	38-1095	38-1096
Per cent passing 1-in. screen...	99.5	100.0	100.0	99.9
Per cent passing ¾-in. screen...	98.2	99.3	99.6	99.8
Per cent passing ½-in. screen...	97.1	98.7	98.8	99.5
Per cent passing No. 4 sieve....	95.0	96.8	96.2	98.5
Per cent passing ⅜-in. sieve....	94.2	96.4	95.1	98.1
Per cent passing No. 10 sieve....	93.3	95.7	93.7	97.7
Per cent passing No. 20 sieve....	90.3	93.7	91.0	95.6
Per cent passing No. 40 sieve....	83.7	89.9	87.6	91.6
Per cent passing No. 200 sieve....	70.2	85.2	79.5	86.0
Silt (.05 to .005 mm. diam.)....	38.0	51.0	47.0	47.0
Clay (smaller than .005 mm.)...	24.0	26.0	25.0	31.0
Colloids (smaller than .001 mm.)	11.0	12.6	15.0	17.0

Physical Test Constants—Material Passing No. 40 Sieve

Lab. No.	L.L.L.	L.P.L.	P.I.	F.M.E.	SH. LIM.	SH. Ratio	F.M.E.	V.M.E.
38-1093..	31.8	14.4	17.4	20.2	13.5	1.89	24.2	26.9
38-1094..	36.5	19.9	16.6	25.0	15.9	1.81	29.7	31.1
38-1095..	35.2	18.4	16.8	22.2	14.9	1.82	27.1	34.0
38-1096..	42.5	20.9	21.6	36.5	13.6	1.90	32.8	33.3

Optimum Moisture and Maximum Density

Lab. No.	*Per Cent Optimum Moisture	*Dry Weight, Lbs. Per Cubic Foot with Optimum Moisture
38-1093.....	17.0	109.5
38-1094.....	19.7	103.5
38-1095.....	19.5	103.3
38-1096.....	20.0	102.3

\*Tests made on that portion of the material passing the No. 4 sieve.

TABLE III—DENSITY OF DURABILITY SPECIMENS

Designed Cement Content Per Cent	DENSITIES		SOLIDS	
	—Pounds Per Cu. Ft.—	—Dry Wt.—	Per Cent by Volume	Obtained in—
		Obtained in—		
		Freeze-Thaw		Freeze-Thaw
by Molded Volume	Theoretical	Wet-Dry Specimens	Wet-Dry Specimens	Wet-Dry Specimens
7.2	113.8	112.6	110.1	67
9.0	113.2	112.9	111.8	67
10.9	112.7	112.7	112.0	66

\*DURABILITY DATA FROM TWELVE CYCLES OF TESTS

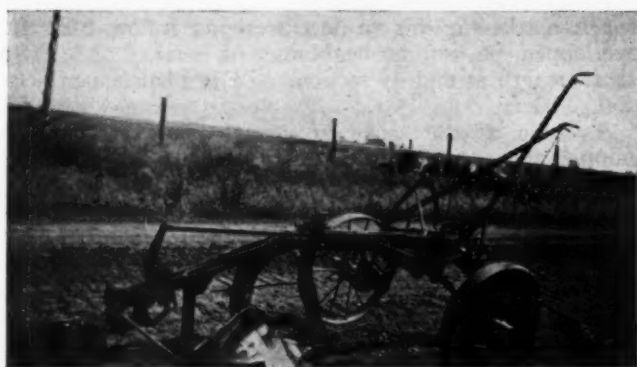
Cement Content Per Cent by Volume of Molded Specimen	TOTAL SOIL LOSS	
	Per Cent of Original Dry Weight	Wet-Dry Freeze-Thaw
7.1	7.2	10.4
9.0	4.3	3.2
10.9	2.7	1.3

\*The durability specimens were compacted with 13.1 per cent moisture.

It can be seen that the Portland Cement Association recommendations and the Missouri State Highway Department findings are in substantial agreement as to the quantity of cement required for satisfactory hardening and durability.

### Design

The design specified a uniform compacted soil-cement stabilized roadway thickness of 6 in., 22 ft. in width. The specified cement content was 9 per cent by volume of compacted roadway with the exception of a section 25 ft. in length at the beginning and ending of each processing section on which the cement content was increased to 10 per cent by volume of compacted roadway. The optimum moisture percentages shown in Table II served as a guide; however, the quantity of water necessary to add to raise the moisture percentages to the



20-In. Single Plow, Used for Loosening Roadbed to Specified Depth.

optimum on each processing section was determined by moisture-density tests made in the field during construction.

### Detailed Description on Construction Procedure

As the contractor and his crew were inexperienced in this type of construction, it was decided to start with a rather short section and increase the length of subsequent sections as the superintendent and crew acquainted themselves with their new duties. In accordance with this decision a section 600 ft. long was cement processed the first day, 800 ft. the second day, 1,000 ft. the third day and 1,300 ft. each working day thereafter, with the exception of three days on which shorter sections were processed.

Removal of the protective covering on the prepared sections 1,300 ft. in length was usually commenced about 4:30 A. M. and the final smooth rolling was completed about 5:30 P. M.

A more comprehensive picture of the construction procedure may be presented by dividing the work into two major operations and subdividing these major operations into their several steps.

#### I—Preliminary Preparation

(a) Removing vegetation from the roadbed and shaping the existing road surface to conform to that shown on the plans.

This work which was completed over the entire length of the project before any cement processing was done, involved removal of vegetation by blading, loosening the compacted surface layer by light scarifying, and shifting the loosened material to correct deficient or excessive crown (1)†, irregularities in the grade, warped or tilted surface, and super-elevation on curves.

†The inserted numbers refer to Comments Regarding Construction.



Disk Harrow Pulverizing Loosened Roadbed Material.

(b) Preparing the roadbed material for cement processing.

This work was completed not later than the day preceding that on which cement processing was done. The first step in this operation was, if necessary, the reshaping of the road surface to conform to that shown on the plans.

Grade stakes were then set by the engineer at 50 ft. intervals offset 4 ft. on each shoulder, and driven to the elevation of the road surface at centerline on tangents and to the elevation of the outer and inner edges on super-elevated curves.

The entire width of the roadbed to be processed was first scarified to a depth of approximately 4 in. (2) and then plowed to the desired depth, using a 20 in. single, mounted plow (3), for this purpose. Plowing (4) was commenced adjacent to the centerline and progressed in successive round trips towards the edges, depositing the plowed material towards the centerline. The edges were marked with laths, set in 4 ft. from the grade stakes and the final round trip with the plow produced a vertical, well defined edge to the full specified depth.



Gang Plow Turning Soil Clods to Surface During Pulverizing Operations.

Pulverizing was accomplished by repeated trips with the disk harrows and occasional trips with the gang plow. This equipment became available when moist mixing was completed on the section being cement processed.

When the loosened material was pulverized to such an extent that at least 70 per cent of the soil fraction passed the  $\frac{1}{2}$  in. circular screen, the surface was flattened by blading and covered with sisal kraft paper (5) to protect it against wetting by rain.

(c) Stockpiling cement.

The cement was hauled to the job during the pulverizing operations, and stockpiled in the required amounts on "board-mats" placed at 50 ft. intervals on one shoulder. The stockpiles of cement were then covered with sisal kraft paper to protect the cement against wetting by rain.



*Blading Material Forward at Junction of Sections.*

## II—Cement Processing

(a) Removing protective covering, distributing and spreading cement.

The protective covering was removed and placed far enough away from the roadway so it would not be in the way of equipment during processing operations.

Immediately after the protective covering was removed the pulverized material to full depth and width for a distance of 5 ft. from the header at the end of the previously completed section was bladed forward and spread uniformly over the surface of the undisturbed pulverized material for a distance of 20 ft. Board-mats were then placed to protect the subgrade under the excavated 5 ft. section, and all tractors used in pulling the processing equipment were turned on this section (6). A laborer was assigned at this location to keep the board-mats in place, shovel in material cast on the shoulders, and maintain the 20 ft. stretch of lapped material so that it could be properly processed.

The lines for distributing the sacks of cement were established by setting laths at 50 ft. intervals, in three rows, one row along the centerline and a row 7 ft., 4 in., each side of the centerline.

Spacing of the individual sacks of cement along these lines was accomplished by scratching marks on the surface of the pulverized material at such intervals as would produce a mixture containing the specified quantity of cement. The marks were made with measuring sticks cut to the prescribed lengths. The distance be-



*Wooden "Header" in Place at End of Completed Section.*

tween marks on this project were as follows: 20 ft. overlapped portion at beginning of section, 2.18 ft.; 25 ft. length at end of section, 2.73 ft.; balance of section, 3.03 ft.

As soon as the sacks of cement were placed and emptied the empty sacks were cast to one side and the laths were removed.

The cement was spread with a motor patrol grader, maintaining a straight blade during the spreading. Hand rakes were then used to correct any noticeable rich or lean spots.

(b) Dry mixing the cement with the pulverized roadbed material.

Disk harrows were the only equipment used during the early stages of dry mixing. The first few trips were made with the disks adjusted so the cutting depth and tendency to throw the material were held to a minimum (7). After the cement was partially cut into the pulverized material the disks were adjusted so as to penetrate to their maximum depth and disking was continued until a uniform and intimate mixture of soil and cement was obtained to the full cutting depth (8).

The gang plow was then used to turn the material over and from then on dry mixing became a routine process, consisting of repeated trips with the gang plow, disk harrows and motor patrol grader.



*Prepared Roadbed Material and Cement Stockpiles Covered with Sisal Kraft Paper.*

Dry mixing was continued until a uniform and intimate mixture of soil and cement was obtained to the full depth of the pulverized material. The surface was then shaped and the material was considered in condition for moist mixing.

The empty cement sacks, tools, etc., were gathered up and disposed of during the dry mixing but the protective covering was left alongside the section until it was certain that processing could be completed before rainfall occurred.

(c) Applying water and moist mixing.

Water was applied with a 1,000 gal. capacity, pressure distributor equipped with spray bars 11 ft. in width. Applications of water were made at a rate of  $\frac{1}{2}$  gal. per square yard and the distributor was filled from supply tank trucks at each end of the section being processed. Immediately following each water application the material was disked so as to avoid concentration of water near the surface.

More mixing was necessary to disperse the water between the first few applications than between subsequent applications, probably due to the resistance of adsorbed air on the surface of the finer particles. When additions of water and mixing overcame this resistance (indicated by greater ease in mixing), to the maximum depth penetrated by the disk harrows, the underlying, more or less, dry layer was turned to the surface by plowing with the gang plow. As in dry mixing, moist

mixing now became a routine of alternate applications of water, disking and plowing and occasional blading to shape the surface and reclaim material which had sloughed on the shoulders. Moist mixing was continued until the moisture was uniformly distributed throughout the entire depth of the mixing and the moisture percentage, on a dry weight basis, did not vary more than 2 per cent plus or minus from the specified optimum percentage as determined by the engineer.

When this requirement was fulfilled, the "header" was removed from the end of the previously completed section the board mats taken up and the material which was bladed forward, before the cement was spread, was bladed back in place. This material was bladed back in such a manner that upon completion of sheepfoot and pneumatic tire compaction the elevation of the surface, at and in the immediate vicinity of the joint, was approximately 1 in. higher than the finished surface of the adjoining completed section. A final loosening of the material over the entire length of the section was then obtained by several round trips with the 10 ft. disk harrow, adjusted for full cutting depth (9). The material in the immediate vicinity of the joint was



*General View Showing Cement Dumped on Surface Ready to Be Spread.*

loosened by backing the disk harrows up to the joint at the end of each round trip. No other piece of equipment or vehicle of any kind was permitted to travel over the section between the final loosening and the beginning of sheepfoot compaction.

(d) Compacting, shaping and finishing.

Compaction was obtained with sheepfoot tampers. The tamper feet penetrated almost to the bottom of the mixture during the initial trips and worked gradually towards the surface during subsequent trips. The material next to the joint was compacted by running the sheepfoot tampers backward and forward several times at the end of each round trip (10).

When the bottom two-thirds depth of the mixture was compacted as indicated by a decrease in the depth penetrated by the tamper feet, the surface was shaped by blading to conform to that shown on the plans. Spike tooth farm harrows were then attached behind the sheepfoot tampers and tamping was resumed. The harrow teeth were adjusted from time to time so that the teeth just penetrated sufficiently to loosen the surface of the tamper imprints. The surface contour was checked frequently by hand level readings during this stage of compaction, and any variations from that shown on the plans were corrected immediately by blading. The



*Spreading Cement with Motor-Patrol Grader. This Was Followed by Hand Raking.*

traveling speed of the sheepfoot tampers was decreased during the last few round trips and the spike tooth harrows were adjusted so that the teeth were practically flat, serving essentially as a drag. On extremely hot, dry days it was necessary to add one or two light applications of water during the latter stages of sheepfoot tamping.

The thickness of loose material remaining on the surface when compaction with sheepfoot tampers is complete will no doubt vary, amongst other things, with the character of the soil, weight of tamper and type of tamper feet. The thickness on this project ranged between 1 and 1½ in.

Pneumatic tire rolling to compact the loose surface material was the next step. However, before this was commenced the surface was given a final shaping. This necessitated very little movement of material and in no case was it necessary to blade through the mulch to the compacted material beneath. In other words, the thickness of loose material was uniform and the surface contour was very nearly that shown on the plans when sheepfoot tamping was completed.

The surface mulch was compacted by pneumatic tire rolling using all the pneumatic tired equipment available, including distributor, supply tank trucks, and other trucks for this purpose. Some very light blading was done during pneumatic tire rolling to smooth out any evidence of slight rutting.

The final operation before smooth rolling was the blading of a smooth, uniform surface at the junction between sections. This was done by operating the motor patrol grader on the surface of the previously



*Dry Mixing Cement with Pulverized Roadbed Material.*



*Plowing Unmixed Material Along Edges During Dry Mixing.*

completed section and shaving off the excess height of material built into the surface of the section under construction. This operation required a sharp cutting blade and a skillful operator. The material shaved off was wasted on the shoulder.

The first trip with the smooth roller was made along one edge, the outside edge of the roller extending out about 1 ft. on the shoulder. The entire width of the surface was then rolled, overlapping about one-half width of the roller on each successive trip.

Upon completion of smooth rolling a transverse line was established at the end of the sections, where it was apparent that the cement content, density and thickness



*Applying Water During Moist Mixing.*

were satisfactory over the entire stabilized width. A vertical face to the full depth of treatment was then cut along this line and after removing the loose material a "wooden header" was staked against the end of the section.

As soon as the "header" was placed the surface of the completed section was primed with RT-3 tar applied at the rate of 0.2 gal. per square yard. The prime, which was applied to prevent loss of moisture by evaporation, was the only method of curing (11) used.

An "armor coat" surface treatment was constructed after the cement stabilized base was completed over the entire length of the project. The surface treatment consisted of an application of (200-250) penetration asphalt, applied at a rate of  $\frac{1}{2}$  gal. per square yard. This was immediately covered with approximately 40 lb. of crushed stone chips per square yard.

TABLE IV—SPECIFICATIONS FOR CRUSHED STONE COVER MATERIAL

	Per Cent
Passing $\frac{3}{8}$ -in. circular screen.....	100
Passing $\frac{1}{2}$ -in. circular screen.....	80-100
Passing $\frac{3}{4}$ -in. circular screen.....	0- 5



*Moist Mixing.*

### Comments Regarding Construction Procedure

(1) \*†Excessive crown was corrected in the existing road surface without loss of road metal by making the correction on one-half width of the roadway at a time, the compacted surface layer first being loosened and bladed on the opposite half. After the crown was corrected on both halves the surface layer containing the road metal was spread uniformly over the entire width to be stabilized.



*Blading in Sloughed Material from Shoulder.*

(2) Shaping the road surface to conform to the design frequently resulted in considerable variation in the depth of loose material on different portions of the roadway. This condition made it difficult to control the depth of plowing, and it was found that by scarifying the entire width to be stabilized to a depth of approximately four inches before plowing, a uniform thickness of loose material was obtained and the depth of plowing could be controlled more accurately.



*Compacting with Sheepfoot Tampers.*

(3) The roadbed on two sections was loosened with the gang plow and it was found to be more efficient than the 20 in. single plow; however, it was impossible to use it for this purpose on the balance of the sections as it was the only one available, and it was necessary to use it in the cement processing operations which were being carried on simultaneously with the preparation of the next section.

(4) Particular care in this first plowing operation was well worth the trouble involved as a smooth uniform subgrade was established at the desired depth. On this project a laborer followed the plow and checked the depth of furrow at frequent intervals. However, the plow operator soon became so skillful that it was seldom necessary to call his attention to variation in depth.

(5) To adequately protect the edges the protective covering should be not less than 4 ft. wider than the width to be stabilized.

(6) Considering the heavy tractors used on this project, it was deemed advisable to turn short of rather than on the surface of the adjacent completed section.

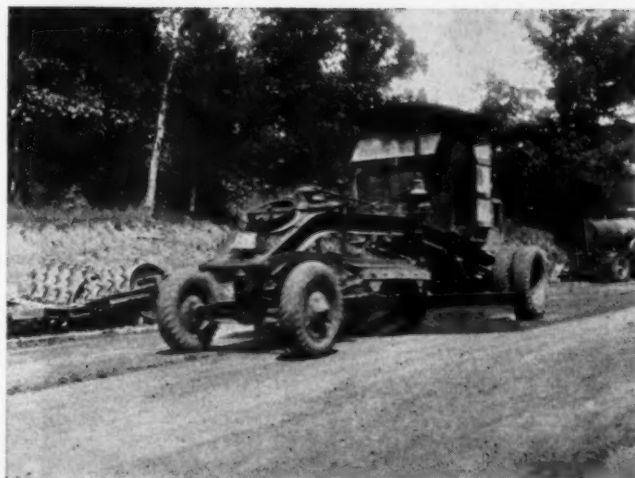
(7) Care in disking is of special importance on windy days as otherwise considerable cement may be blown off the roadway.

(8) If the soil and cement are not thoroughly mixed by disking before the mixture is turned over with the gang plow the cement will segregate and settle to the bottom.

\*†The numbers refer to inserted numbers in Detailed Description of Construction Procedure.



*Spike Tooth Harrows Were Attached When the Bottom Two-Thirds of the Material Was Compacted.*



*Final Shaping After Sheepfoot Compaction Was Completed. Note Slight Amount of Loose Material Carried by Blade.*

(9) The material should be in as loose a state as possible so as to obtain compaction from the bottom upward.

(10) Cross tamping is recommended if the roadway is of sufficient width to permit operation of the tamping equipment.

(11) The tar prime was only partly effective in preventing surface checking and it is felt that a covering of damp straw or earth as recommended by the Portland Cement Association would have been more satisfactory.

### Field Control Tests

The project engineer was responsible for the work being prosecuted in accordance with the specification. The field control tests included sieve analysis to determine the degree of pulverization and field moisture, optimum moisture and maximum density tests, which served as a basis for estimating the total quantity of



*Rolling with Pneumatic Tired Equipment. All Equipment with Pneumatic Tires Was Used for This Purpose.*

water to be added during moist mixing and density to be obtained in the finished base. The thickness, moisture content and density of the finished base was determined on the day following construction.

### Data on Personnel, Equipment and Time from Which Cost of Construction May Be Estimated

For the benefit of the construction engineer and the contractor a list of the engineering and construction personnel, equipment used, time required for the dif-



Flat Rolling, the Roller Was Overlapped One-Half Width on Successive Trips.

ferent operations and miles traveled by various types of equipment per mile of cement processing are given. From this information the experienced contractor will be able to form his estimate of the actual cost of construction, which for obvious reasons cannot be given here.

#### Engineering Personnel:

Project engineer and two assistants, one of whom was familiar with soil testing methods.

#### Construction Personnel:

Superintendent, foreman, four semi-skilled laborers and 14 common laborers.

TABLE V—LIST OF EQUIPMENT USED

- 2—65 crawler type tractors.
- 1—60 crawler type tractor
- 1—35 crawler type tractor.
- 2—Motor patrol graders.
- 1—Blade grader
- 1—Scarifier
- 1—10 ft. width offset disk harrow (22 in. dia. disks).
- 1—5 ft. width offset disk harrow (22 in. dia. disks).



Water Was Pumped from the Pond Into a 1,000 Gal. Reservoir Tank Mounted on a Trestle. The Supply Tank Trucks Were Backed Under the Reservoir Tank and Filled Through a 4 in. Outlet Pipe.

- 1—Sheepsfoot tamper assemblage consisting of 4 units attached, two parallel and two tandem.
- 1—Gang plow (3 14 in. plows in gang).
- 1—20 in. single mounted plow.
- 1—Spike tooth farm harrow.
- 1—10-ton, smooth tandem roller.
- 1—Triplex C. H. E. pump.
- 1—Wisconsin pump.
- 1—1,000 gal. reservoir tank mounted on a trestle.
- 1—Pressure distributor (1,000 gal. capacity).
- 4—Supply tank trucks (1,000 gal. capacity each).
- 5—Trucks.

#### Miscellaneous Materials and Tools

2,000 lin. ft. of protective cover material (Fabricated into sections 24 ft. wide and 50 ft. long).

26 squares of protective cover material for covering cement stockpiles.

Board mats, header board, hand rakes, sledges, pick mattocks and shovels.

TABLE VI—TOTAL TIME REQUIRED FOR PRINCIPAL OPERATIONS PER MILE OF CONSTRUCTION BASED ON THE AVERAGE TIME REQUIRED TO CONSTRUCT EIGHT TYPICAL 1,300 FT. SECTIONS ON THIS PROJECT

Preliminary Preparation	Hours
Removing vegetation and shaping existing road surface...	11
Reshaping road surface.....	2
Scarifying, plowing and pulverizing.....	28
Stockpiling cement .....	12
Placing protective covering .....	4
Cement Processing	
Removing protective covering, distributing and spreading cement .....	11
Dry mixing, soil and cement.....	9
Applying water and moist mixing.....	15
Sheepsfoot compaction and shaping.....	10
Pneumatic tire rolling and light blading.....	3
Smooth rolling for final finish.....	4

TABLE VII—MILES TRAVELED BY VARIOUS TYPES OF EQUIPMENT, PER MILE OF CEMENT PROCESSING, EXCLUSIVE OF DISTANCE TRAVELED IN TURNING EQUIPMENT AROUND AT END OF SECTIONS

Operation	Type Equipment	Miles Traveled
Dry mixing .....	Disk harrow (5 ft. wide).....	34
	Disk harrow (10 ft. wide).....	30
	Gang plow .....	18
	Motor patrol grader .....	4
Moist mixing .....	Disk harrow (5 ft. wide).....	58
	Disk harrow (10 ft. wide).....	52
	Gang plow .....	24
	Motor patrol grader.....	6
	Distributor .....	20
Compacting and shaping..	Sheepsfoot tampers .....	32
	Motor patrol grader .....	10
	**Spike tooth harrow.....	12
	Pneumatic tire rolling (trucks, etc.) .....	64
Final finishing .....	Smooth roller .....	10

\*\*The spike tooth harrows were attached behind the sheepsfoot tampers after the bottom two-thirds depth of material was compacted.

This article represents an attempt to describe the construction of an actual soil-cement stabilization project in such a way as to be of greatest benefit to the contractor and construction engineer. It is hoped that the description and technical data given are sufficient for this purpose.

MISSISSIPPI TO LET WORK COSTING \$6,666,667—Contracts calling for an expenditure of \$6,666,667 will be let during the next three months by the Mississippi State Highway Department. One letting involving \$310,900 was held on Nov. 29. There will be three other monthly lettings. The work involved includes 169.6 miles grading and drainage and 269.8 miles of various types of pavement including Portland cement concrete and bituminous types.

# PAVING AND OTHER CONSTRUCTION ON HIGHWAY 61 NEAR NATCHEZ, MISS.

*Contractor Uses Tandem Mixers Successfully*

By JOHN C. BLACK  
Field Editor, Roads and Streets

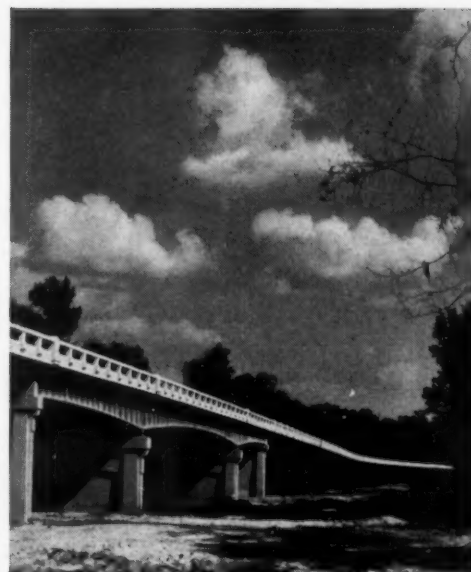


Photo by W. A. Russell,  
Mississippi State Highway Dept.  
Homochitto River Bridge.

**P**AVING of U. S. Route 61 between Woodville and Vicksburg, Mississippi, is nearing completion, and it is expected that the road will be open for the entire distance of 104.5 miles by the spring of 1939. North of Vicksburg the route is completed and open to traffic all the way to a point 8 miles south of Clarksdale, where the present construction project ends.

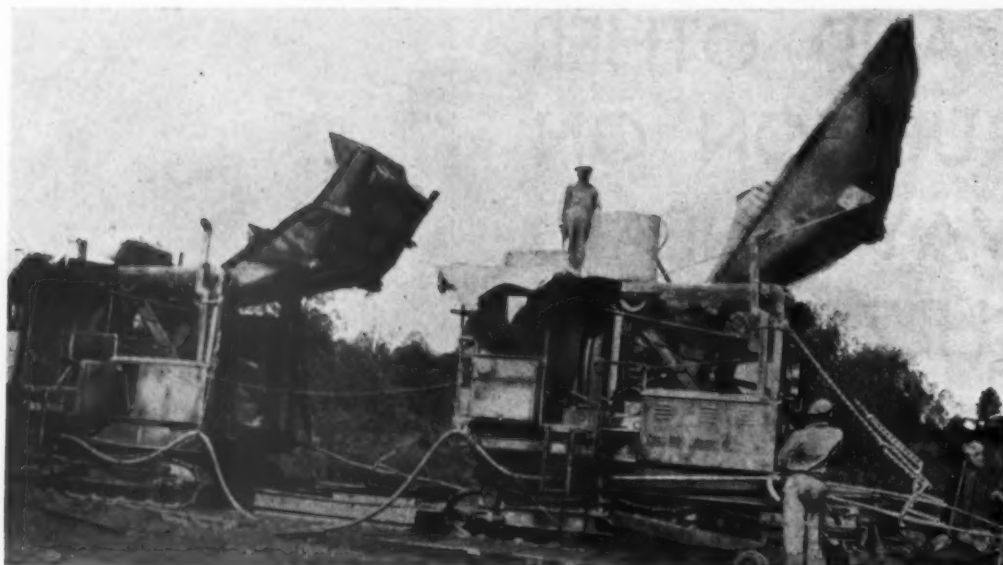
I covered the Woodville-Vicksburg section in July 1937, when major grading operations and bridge construction in various stages were under way, and gave a general account of the work in the August 1937 number of *ROADS AND STREETS*. This year, following the bituminous conference at Biloxi in October, I traversed the same route as a guest of the Mississippi State Highway Department.

Except for a few miles at its southern end, and some comparatively short intervening stretches, the construction is over irregular topography involving frequent deep cuts and high fills. At two points there are short 6.4 per cent grades, but otherwise the maximum is 5 per cent. Curves, though numerous, are limited to 5 degs. All curves of 4 degs. or over have 250 ft. spiral transitions. For some 6 miles immediately south of the Homochitto River in Wilkinson County, there is such nearly continuous curvature that a 22 ft. slab is called for, as affording both cheaper construction and greater safety than the ordinary 20-ft. section with the necessary widenings.

H. S. McElroy is project engineer from Natchez to Woodville. I am much indebted to him and his asso-



*In a Loess Cut South of Vicksburg. Note Successful Sodding of Shoulders.*



*Cobb Brothers' Tandem Mixer Set-Up — Two Kohring 27-E's — Sept 15, 1938.*

*Photo by J. W. Brown, Mississippi State Highway Dept.*

ciates for a thorough trip over the line and for information furnished.

### Type of Pavement

In Adams County, between Natchez and the Homochitto River, the pavement is complete. It is a 20-ft. 7-5-7 concrete slab formed with two parabolas, the upper surface having a 1-in. and the lower a 3-in. crown. The cross-sectional area is 9.444 sq. ft. Concrete is a D. R. volume, 1:1.776:3.448 (1.45 cement factor) mix, reinforced with welded wire mesh.



*At the Stock Pile. Blaw-Knox Bin and Batcher. Note the High Boarding to Keep Material Off Truck Loading Station.*

Only one type of transverse joint is used— $3\frac{3}{4}$  in. pre-moulded bituminous, spaced 40 ft. The longitudinal joint is a  $\frac{1}{4}$  in. premoulded strip 2 in. deep. A lip curb 8 in. wide is constructed monolithic with the slab on the long slopes, of which there are many. Run-off is received by an interesting type of catch basin recently developed by the Department, and described in the November issue of *ROADS AND STREETS*.

### Construction with Tandem Mixers

In building the 10.743 miles of 20-ft., 7-5-7 slab in Adams County, the contractor, Cobb Brothers Construction Co., Inc., of Meridian, Mississippi, used two Kohring 27-E pavers operating in tandem. A standard 32.58 cu. ft. batch was mixed 32 sec. in the first paver and then discharged directly into the skip of the second, where the mixing time was 28 sec. In measuring the 60-sec. mixing requirement of the Mississippi specifications, no allowance was made for the time consumed in transfer between mixers. The contractor considers the tandem set-up satisfactory, and is continuing it on his job south of the Homochitto in Wilkinson County.

**Progress and Payroll**—The maximum day's progress on the work in Adams County was on August 19, when the pour totalled 2,251 lin. ft. of pavement, with an area of 5,002 sq. yd. and a volume of 810.8 cu. yd. Figured on the basis of 9.444 sq. ft. sectional area of the slab, the volume would have been 788 cu. yd., indicating a 2.9 per cent excess due to all causes, including irregularities in subgrade.

Progress reports and payrolls from July 28th to September 21st inclusive (all that I was able to get on my brief call at the project office) show a substantial increase from week to week in amount of pavement laid, but only moderate improvement in labor efficiency and labor cost per unit laid after the first week.

Following are the daily and weekly data. The payroll is for all of the contractor's labor during the period—administrative, skilled labor, intermediate and unskilled.

It covers not only work done in constructing the slab, but supplementary grading, sodding, culvert and other drainage construction as shown on the estimates. It includes truck drivers hauling aggregate from central stock piles to the job, but does not include labor engaged in producing aggregate, all of which was purchased from a commercial producer with pits at various

points along the line. Major grading and drainage were completed in 1937 by another contractor.

PROGRESS AND PAYROLL RECORD OF 10.7 MILES  
OF 20-FT. 7-5-7 PAVEMENT IN ADAMS  
COUNTY

Date	Pavement Laid Lin. Ft.	Sq. Yd.	Av. No. Men	Man-Hours for Week	Payroll for Week	Man-Hours Per Sq. Yd. Laid	Payroll Per Sq. Yd. Laid
July—							
28.....	762	1,693					
29.....	568	1,262					
30.....	859	1,909					
Week..	4,864		211	5,434	\$1,945	1.12	\$0.40
Aug.—							
1*....	739	1,642					
2.....	1,442	3,204					
3*....	845	1,878					
4†....							
5*....	840	1,867					
6.....	1,820	4,044					
Week..	12,635		233	6,927	2,377	0.55	0.19
8*....	1,198	2,662					
9†....							
10†....							
11*....	808	1,794					
12.....	2,081	4,624					
13*....	1,346	2,991					
Week..	12,071		230	6,532	2,247	0.54	0.19
15†....							
16†....							
17†....							
18.....	2,004	4,452					
19.....	2,251	5,002					
20.....	1,883	4,184					
Week..	13,638		211	6,543	2,246	0.48	0.16
22.....	1,864	4,142					
24*....	727	1,615					
25*....	607	1,349					
26.....	2,123	4,718					
27.....	2,178	4,840					
Week..	16,664		251	9,213	3,002	0.55	0.18
29*....	537	1,193					
30.....	1,515	3,367					
31.....	1,917	4,260					
Sept.—							
1*....	828	1,840					
2.....	2,024	4,498					
3.....	1,665	3,700					
Week..	18,858		277	9,790	3,206	0.52	0.17
5.....	1,687	3,749					
6†....							
7.....	2,205	4,900					
8.....	2,124	4,720					
9.....	1,964	4,364					
10.....	2,009	4,46					
Week..	22,197		271	9,783	3,232	0.44	0.15
12†....							
13.....	2,045	4,544					
14*....	1,130	2,529					
15.....	1,442	3,204					
16.....	1,927	4,282					
17.....	1,162	2,582					
Week..	17,141		277	9,614	3,155	0.56	0.18
19.....	998	2,218					
20.....	1,084	2,440					
21.....	1,531	3,402					
Week..	8,060		247	7,351	2,433	0.91	0.30

\*Half day—due to rain or wet soil.

†No work—due to rain or wet soil.

When possible, the contractor worked six 10-hour days per week, but due to weather conditions as indicated in the table, was seldom able to exceed five days and sometimes was obliged to be satisfied with even less. Skilled labor was allowed a 60-hour week, but

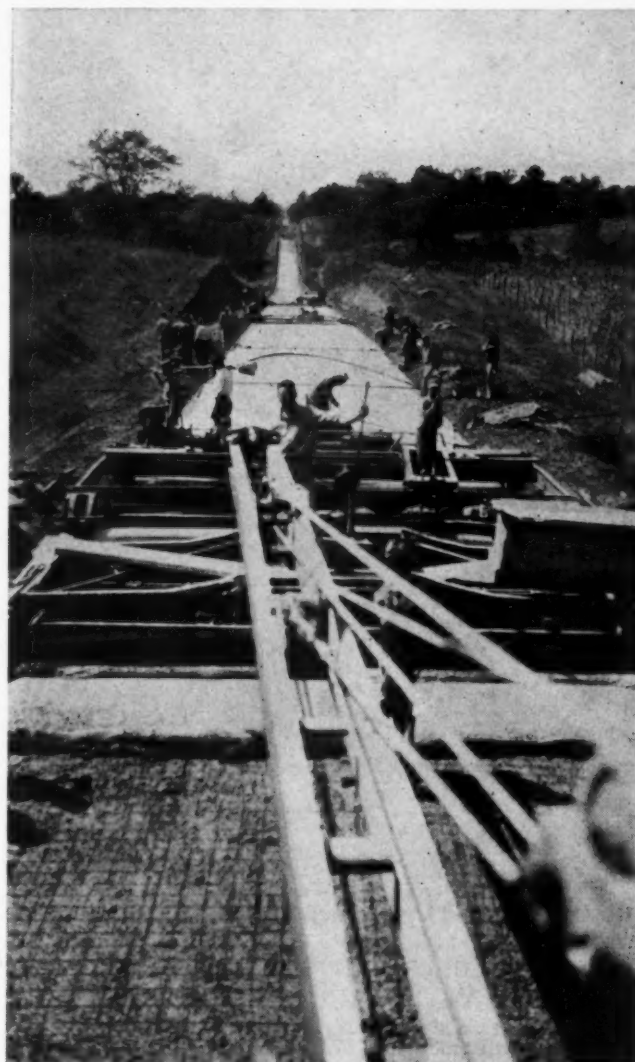


Photo by J. W. Brown,  
Mississippi State Highway Dept.

View Looking Back from Mixer.

semi-skilled and common was limited to 40 hours by federal regulation. Following are the important minimum labor rates in effect throughout the job:

Skilled labor—65 ct. per hour.

Intermediate labor—35 ct. per hour.

Unskilled labor—22½ ct. per hour.



Trimming Subgrade and Shoulders with Caterpillar Diesel Patrol.



Photo by J. W. Brown,  
Mississippi State Highway Dept.  
*Bridge Over the Big Black.*

**Costs**—Contract quantities and prices are as follows:

**COST OF 10.743 MILES OF 20-FT. 7-5-7 PAVEMENT AND ROADWAY ITEMS IN ADAMS COUNTY**

13,348 cu. yd. unclassified excav.....	@ \$0.25	\$3,337
1,000 cu. yd. half mile units: overhaul.....	@ 0.10	100
96,711 sq. yd. sprigging .....	@ 0.02½	2,418
8,179 sq. yd. solid sodding .....	@ 0.18	1,472
28,584 sq. yd. strip sodding .....	@ 0.08	2,287
337 cu. yd. gravel surface course.....	@ 2.00	674
12 lin. ft. 30-in. concrete pipe culvert.....	@ 6.00	72
1,044 lin. ft. 10-in. corrugated metal pipe culvert .....	@ 1.00	1,044
158 lin. ft. 15-in. corrugated metal pipe culvert .....	@ 1.60	253
50 lin. ft. 24-in. corrugated metal pipe culvert .....	@ 2.50	125
32 concrete spillway basins (SW-6-A).....	@ 40.00	1,280
2 concrete spillway basins (SW-6-B).....	@ 40.00	80
17 concrete spillway basins (SW-5).....	@ 40.00	680
1 concrete spillway basin (SW-2).....	@ 40.00	40
20 lin. ft. concrete spillway trough.....	@ 2.00	40
556 sq. yd. concrete gutter .....	@ 2.00	1,112
29,608 lin. ft. raised edge curb .....	@ 0.04	1,184
5,175 lin. ft. wooden guard rails (rustic)....	@ 0.80	4,140
316 sq. yd. concrete bridge end slabs.....	@ 4.00	1,264
11.73 cu. yd. class "B" culvert concrete....	@ 30.00	352
1,187 lb. reinforcing steel .....	@ 0.06	71
6 15-in. elbows corrugated metal pipe.....	@ 6.50	39
2 24-in. elbows corrugated metal pipe.....	@ 16.00	32
485 lin. ft. center line traffic stripe for bridges .....	@ 0.02	10
Total bid on roadway items.....		\$ 22,106
126,111 sq. yd. reinforced concrete pavement.....	@ 1.51	
Total .....		\$190,428
Grand total .....		\$212,533

**The Change to a 22-Ft. Width and Thicker Section**

The Homochito River separates Adams County from Wilkinson, and on October 13, the day of my visit, Mr. D. F. Gibbs, construction superintendent for Cobb

Brothers, was busily engaged in changing over his finisher (a Jaeger), screeds, floats, and other units to fit the 22-ft. section beginning at the south end of the bridge. He was using factory-made adjustments or extensions wherever possible, some of them having been ordered especially for the present purpose, and was completing the change in only a trifle more than one day's time. The extra cost of factory goods, he was emphatic in stating, was much less than the value of time necessary to do the cutting and fitting otherwise required.

The 22-ft. pavement has a 9-6-9 section with a 1.21-in. parabolic crown. The under surface is parallel to the upper for the inner 16 ft. of the section, and is bent downward for the outer 3 ft. to secure the 9-in. edge width.

A 9-6-9 section was also used for a portion of 20-ft. pavement near the southern end of the project, where a clay subgrade, subject to rather large volume changes, indicated need for greater strength. The crown at this point is 1 in., with other design features similar to those of the 22-ft. width.

The reader may note that the 9-6-9 section in Wilkinson County costs less per square yard than the 7-5-7 section in Adams County. This is due to a tremendous drop in the price of cement between the letting of the two contracts, and to a much lower price of sand and gravel delivered in Wilkinson County.

**More Costs**—Cobb Brothers' work in Wilkinson County is under another contract, prices and estimated quantities being given in the table below. Part of this work is already completed, the present contract being merely the closing portion. The tandem mixer set-up will be used as on the Adams County job.

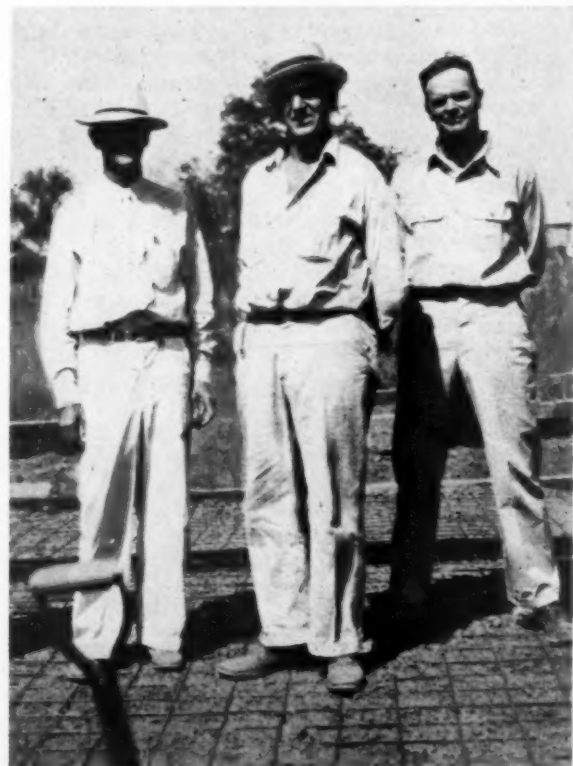


Photo by W. A. Russell,  
Mississippi State Highway Dept.

Key Men for Cobb Brothers: D. F. Gibbs, Construction Supt.; Bob Durham, Mixer Foreman; Charles Lee, Finisher Operator.

# COST OF 15.341 MILES OF 9-6-9 PAVEMENT AND ROADWAY ITEMS IN WILKINSON COUNTY

31,943 cu. yd. unclassified excavation .....	@ \$0.22	\$ 7,027
1,000 cu. yd. top soil for eroded slopes.....	@ 0.50	500
10,000 sq. yd. dressing of eroded slopes.....	@ 0.03	300
1,000 cu. yd. half mile units overhaul of top soil for eroded slopes.....	@ 0.10	100
128,823 sq. yd. sprigging .....	@ 0.02½	3,221
14,950 sq. yd. solid sodding.....	@ 0.18	2,691
14,420 sq. yd. strip sodding .....	@ 0.08	1,153
15,950 sq. yd. sprigging of shoulders slopes.....	@ 0.02½	399
1 ton fertilizer (8-4-4) .....	@ 50.00	50
0.5 ton fertilizer (nitrate of soda) per ton.....	@ 60.00	30
687 cu. yd. gravel surface course Alt. No. 2 .....	@ 0.75	515
30 lin. ft. 15-in. pipe culvert Alt. No. 1.....	@ 2.00	60
3 lin. ft. 18-in. concrete pipe culvert.....	@ 3.00	9
2,692 lin. ft. 10-in. pipe downspouts Alt. No. 1 .....	@ 1.36	3,661
78 lin. ft. 12-in. pipe downspouts Alt. No. 1 .....	@ 1.55	121
34 lin. ft. 15-in. pipe downspouts Alt. No. 1 .....	@ 1.70	58
126 lin. ft. 18-in. pipe downspouts Alt. No. 1 .....	@ 2.50	315
21 lin. ft. 18-in. pipe sidedrains Alt. No. 1.....	@ 2.00	42
350 lin. ft. pipe underdrain (8-in. tile).....	@ 0.60	210
4 concrete spillway basins (SW-5 modi- fied—2 grates) .....	@ 40.00	160
2 concrete spillway basins (SW-5 modi- fied 3 grates) .....	@ 46.00	92
3 concrete spillway basins (SW-5 modi- fied—4 grates) .....	@ 69.00	180
87 concrete spillway basins (SW-6A modi- fied) .....	@ 38.00	3,306
17 concrete spillway basins (SW-6A modi- fied) .....	@ 38.00	646
59,355 lin. ft. raised edge curb .....	@ 0.04½	2,671
42 cu. yd. concrete rip rap in bags.....	@ 12.00	504
611 sq. yd. concrete block rip rap.....	@ 3.50	2,138
568 sq. yd. concrete bridge end slabs.....	@ 4.00	2,272
342 cu. yd. Class "D" culvert concrete.....	@ 14.00	4,788
18.07 cu. yd. Class "B" culvert concrete.....	@ 24.00	434
1,993 lbs. reinforcing steel per lb.....	@ 0.06	119
5,505 lin. ft. center line traffic stripe for bridges .....	@ 0.01	55
Total bid on roadway items.....		\$ 37,828
186,576 sq. yd. 9-6-9 reinforced concrete pave- ment .....	@ 1.39	259,340
Grand total .....		\$297,168

**Grading and Bridge Costs**—Final estimates covering grading and bridge construction completed in 1937 and 1938 are as follows:

FINAL ESTIMATE COVERING CONTRACT OF  
CHARLES WEAVER & CO. OF JACKSON, MISS., FOR  
WORK IN ADAMS COUNTY COMPLETED IN  
AUGUST, 1937.

## 10.743 Miles Grading and Bridge Construction

<b>Grading—</b>		
Clear and grub. ....	Lump sum .....	\$ 8,750
Unclassified excav. ....	308,517.7 cu. yd. @ \$0.215	66,332
Culvert concrete .....	1,560,505 cu. yd. @ 23.50	36,674
Reinf. steel .....	173,870.4 lb. @ 0.0465	8,085
15-in. pipe culvert.....	153 lin. ft. @ 1.75	268
18-in. pipe culvert.....	414 lin. ft. @ 2.25	931
24-in. pipe culvert.....	357 lin. ft. @ 3.25	1,160
30-in. pipe culvert.....	702 lin. ft. @ 4.50	3,159
36-in. pipe culvert.....	117 lin. ft. @ 5.50	644
Culvert pipe relaid.....	27 lin. ft. @ 1.50	40
Sprigging* .....	124,855.8 sq. yd. @ 0.025	3,121
Concrete spillway .....	40 lin. ft. @ 4.00	160
R.O.W. markers .....	149 Units @ 2.00	298
Gravel surface course.....	706 cu. yd. @ 2.50	1,765
Roadway Total .....		\$131,387

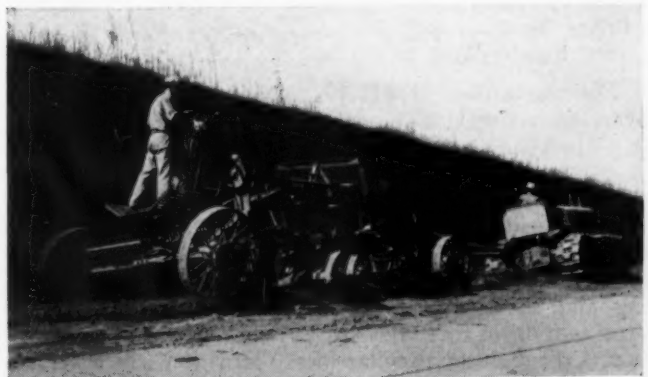
\*This item is for the setting of sprigs of Bermuda grass in rows.

The above work was divided into a "Gravel Section," 52 stations long, and an "Earth Section," covering all the remainder, but unit prices were the same for each.



Fresh Strip Sodding in a Cut. Note the Turned-Up Ends of Sod Set Into the Bank.

<b>Bridges—</b>		
Class "B" bridge concrete.....	426.08 cu. yd. @ \$24.00	\$10,226
Reinforcing steel .....	74,499.0 lb. @ 0.0465	3,464
Structural steel .....	121,913.0 lb. @ 0.045	5,487
Creosoted piles .....	6,308.4 lin. ft. @ 1.00	6,308
Creosoted piles, C.O. ....	326.5 lin. ft. @ 0.50	163
Creosoted timber .....	5.4933 MFBM @ 110.00	604
Bridge railing .....	970 lin. ft. @ 2.00	1,940
Test piling .....	8 Units @ 100.00	800
Conc. block rip rap.....	429.03 sq. yds. @ 3.50	1,502
Bridge Total .....		\$ 30,494
Total Regular Work.....		\$161,881
Force Account Additional.....		288
Grand Total .....		\$162,169



Trimming Ditch and Shoulder with an Old J. D. Adams 12-ft. Blade Pulled by Allis-Chalmers K. This Veteran Dirt Mover Was Going Strong and Appeared Fit for Many More Battles.



Photo by W. A. Russell,  
Mississippi State Highway Dept.

Homochitto River Bridge

**FINAL ESTIMATE COVERING CONTRACT OF  
CHARLES WEAVER CO. OF JACKSON, MISSIS-  
SIPPI, FOR WORK IN WILKINSON COUNTY,  
COMPLETED IN OCTOBER, 1937.**

**15,341 Miles Grading and Bridge Construction**

<b>Grading—</b>		
Clear. and grub., lump sum.....		\$ 21,000
Unclassified excav. ....898,308.8 cu. yd.....@ \$0.2125	190,891	
Overhaul .....49,401 Units .....@ 0.08	3,952	
Culvert concrete .....1632.484 cu. yd.....@ 23.50	38,363	
Reinforcing steel .....202,866 lb. ....@ 0.0465	9,433	
15-in. pipe culvert.....21 lin. ft.....@ 2.00	42	
18-in. pipe culvert.....1,269 lin. ft.....@ 2.50	3,173	
24-in. pipe culvert.....681 lin. ft.....@ 3.50	2,384	
30-in. pipe culvert.....612 lin. ft.....@ 4.75	2,907	
36-in. pipe culvert.....537 lin. ft.....@ 6.00	3,222	
36-in. ex. str. pipe.....237 lin. ft.....@ 6.00	1,422	
18-in. ex. str. pipe.....114 lin. ft.....@ 2.60	296	
24-in. ex. str. pipe.....276 lin. ft.....@ 3.75	1,035	
Sprigging .....358,366 sq. ft.....@ 0.025	8,959	
R.O.W. markers .....427 Units .....@ 2.00	854	
<b>Roadway Total .....</b>	<b>\$287,933</b>	
<b>Bridges—</b>		
Class "B" bridge concrete. 180.29 cu. yd.....@ 24.00	\$4,327	
Reinforcing steel .....29,697 lb. ....@ 0.0465	1,381	
Structural steel .....52,699 lb. ....@ 0.045	2,371	
Cresoted piles .....1,729 lin. ft.....@ 1.00	1,729	
Cresoted timber .....1.188 MFBM .....@ 110.00	131	
Bridge railing .....330 lin. ft.....@ 2.00	660	
Test piles .....2 Units .....@ 100.00	200	
Untrimmed timber founda- tion piles .....336.5 lin. ft.....@ 0.75	252	
Conc. block rip rap.....106.69 sq. yd.....@ 3.50	373	
Footing excav. lowered....7.407 cu. yd.....@ 2.00	15	
Cresoted piling cut-off...114.0 lin. ft.....@ 0.50	57	
<b>Bridge Total .....</b>	<b>\$ 11,497</b>	
<b>Total Regular Work .....</b>	<b>\$299,430</b>	

The above cost of \$11,497 is for the 165-ft. bridge over Piney Creek. This is at the rate of \$69.70 per lin. ft. The roadway width is 24 ft. between curbs.

**Trouble with Fills—Bench Construction**

This Route 61 construction, though mainly satisfactory, has provided a normal quota of engineering and construction worries, foremost of which has the washing and settlement of two high fills during a 14-in. precipitation in three days last April. Most of the location is through the peculiar loess formation which stands naturally in vertical banks, and when cut, is left either vertical or with a  $\frac{1}{4}$  to 1 slope. Fills, however, are of necessity made with either  $1\frac{1}{2}$  or 2 to 1 slopes. Past

history indicates that this will stand usually, but not always. In the cases under consideration the fills—one 42 ft. and the other 36 ft. high—ran out at the tow, following which there was a top settlement of about 12 in. in the one case and 8 in. in the other. The slabs on these settled sections developed severe transverse and diagonal cracks, but have been brought back approximately to their normal level by careful mud jacking, and at present look as if they might serve for a long time. The cracks in each case extend through 3 of the 40-ft. panels. State maintenance forces have replaced the material lost from the fill sides, and it is believed there will be no further serious trouble, as last April's rain greatly exceeded all previous records. We doubt, however, if anyone will venture a positive prophecy.

An interesting feature of some of the fills is the "bench type" of construction in which the fill is given an excess width of 20 ft. until its center height is about half way up to grade. There it is reduced to normal width, leaving a 10-ft. horizontal bench on each side. No pavement settlement occurred on any of these fills as a result of the storm last spring, although water coming in from side ditches and adjacent hill slopes washed some of the ends to an extent requiring replace-



A Slope with a Good Growth of Grass from Sprigs.

ment of material. Bench construction of loess fills is primarily an experiment, and will be watched with interest.

**Loess Bank Problems**

While some of the loess cuts still have the strikingly smooth surfaces left by the grader a year or more ago, others have begun to slough, and presumably will involve a more or less constant maintenance expense to



A "Sprigged" Slope with Loose Earth Cover.

keep the fallen material cleaned up. Where the smooth surface remains, it has hardened slightly in the weather into a sort of skin coat perhaps 1/16 in. thick. This leads one to wonder whether it might be possible to paint or spray such surfaces with some low cost material (neat portland cement mortar, perhaps) which would preserve them indefinitely, provided they are carefully watched and small breaks promptly patched; and provided also, that there is adequate top drainage. Such drainage at present consists only of the conventional small ditch to intercept water from the hill above, which otherwise would flow over the edge and down the side; but it is conceivable that a carefully installed ditch lining of metal, bitumen or concrete, placed very close to the edge of a deep loess cut might save much more than its cost.

### Difficulties in Getting a Good Grass Cover

It has not been easy to secure a good protective cover of grass on cut and fill slopes and shoulders. On the vertical loess, of course, no such cover can be had; but there are a few cuts in other materials, or in mixtures of loess and other materials, on all which, as well as on fills and shoulders, a cover is important.

In Mississippi the material used chiefly for this purpose is Bermuda grass—sometimes with an admixture of certain lawn and other grasses.

As seeding is not generally practical, various systems of sodding or sprigging are used. Because of its high cost, full sodding is done only where an immediate check of erosion is essential. Strip sodding, which consists in the planting of 6-in. sod stripes spaced 2 ft. centers, is used to a considerable extent on side ditches, and to some extent on shoulder and other areas.

The accompanying views show some recently set sod strips in a drainage ditch through a cut, and also some of the successful and well established plantings. In the ditches through loess cuts, the excavation for each sod strip is carried into the face of the bank and continued upward for about 8-in. Sod so placed ultimately spreads to cover not only the bottom of the ditch but also the first few inches of the vertical bank.

"Sprigging," the method most largely used in the sections I visited, is low in first cost (2½ ct. per sq. yd. of area treated is a common contract price) but due to frequent complete or partial failures, is far from being so cheap as the price implies. The method consists in the planting of sprigs of Bermuda grass 12 in. apart on centers in horizontal rows 12 in. apart. Specifications provide that the contractor shall keep it watered if necessary, until the sod shows substantial growth.

The practice is now being followed of throwing a light cover of earth over the areas which have been "sprigged," and then rolling with a small corrugated roller.

While certain sprig-planted slopes have done well, one such being shown in an accompanying picture, it is my impression that the failures considerably exceed the successes, the sprigs being washed out or dying from drought before they ever get a fair start. Naturally erosion follows, entailing repairs which sometimes run to considerable cost, after which it is necessary to start another protective cover growth from the beginning.

While it may be doubted if the average total cost per square yard for all such work would equal the cost of an original full sodding, any class of work involving so many failures should be carefully studied for improvement. A remedy might lie in a more rigid specification for watering. This would involve higher bid



Photo by W. A. Russell,  
Mississippi State Highway Dept.

On Route 61 Just South of Natchez.

prices, but might well effect a net economy. An alternative would be to provide that the contractor deliver a cover of grass growing solidly over the entire area at the end, say, of 12-month period. This would add greatly to the price per square yard, but again might prove economic. Such a basis would have the advantage of leaving the method entirely to the judgment of the contractor, under which circumstance improved methods and the use of methods best adapted to each case ought to result.

### SPECIFICATIONS FOR USE OF CALCIUM CHLORIDE

Revisions of specifications for curing concrete with calcium chloride as dry admixture for high early strength and cold weather concreting and as surface treatment for pavement curing, have recently been adopted as standards by the American Society for Testing Materials.

The new specifications (A. S. T. M. designation C82-38) cover the use of dry flake calcium chloride, as well as the solution form previously prescribed, by simply adding 1 to 2 lb. of calcium chloride per bag of cement used, placed in the skip with the aggregates, before mixing.

Specifications for surface curing of pavements (A. S. T. M. designation C82-38) allow the use of 1½ instead of 2 lb. of calcium chloride per square yard, to be spread over the surface following a minimum of 12 hours of wetted burlap and sprinkling.

It is of interest that since 1931 calcium chloride curing specifications have been included and developed with extensive research and practical usage in A. S. T. M. Standards.



*View of a Finished Road in Motley County During Time of Final Rolling. Shoulders and Ditches Not Finished. This Job Was Practically Identical with the One Described in the Article.*

## ROAD OIL STABILIZED EARTH ROAD IN TEXAS

By R. H. SPILLER

*General Foreman, Division 25,  
Texas State Highway Department*

ON May 19, 1936, the Texas State Highway Commission made an appropriation for constructing an all-sand mixed surfacing on State Highway No. 16 from the south line of Knox County to the Brazos River, a distance of 7.5 miles. The work was done in July and August of 1936, using 3 gal. of RO-3 road oil per square yard to stabilize the  $3\frac{1}{2}$  to 4 in. of soil with which it was mixed.

This project is on a very sandy loam soil and in places was almost a blow sand, with the exception of a few feet on the south approach to the Brazos River Bridge and an experimental stretch of about 300 ft. on the north bridge approach, on a clay or A7 type soil.

The oil used met the following specifications:

"The oil shall be the product of an asphaltic base naturally homogeneous oil or a homogeneous residue of oil. It shall not have been distilled at a temperature high enough to injure the oil by burning, or to produce any carbonaceous matter, and shall not have been obtained by the blending of various grades of oil or the addition of solid asphalt to lighter oils or distillates."

It shall meet the following tests:

Asphalt Content of 100 penetration at 77°F.....	65 to 80%
Specific Gravity 77°F.....	0.95 Min.
Flash Point—Not less than.....	225°F.
Specific Gravity (Engler) at 122°F.....	100 to 160
Loss—20 gms.—5 hrs. at 212°F.....	0-6%
Water and Sediment—Not to exceed.....	1.0%
Bitumen Soluble CS <sub>2</sub> .....	99.5%

This oil cost 4.4 ct. per gallon, delivered in tank cars at railroad point.

### Construction Procedure

The same procedure was used throughout the length of the project and was as follows:

The roadbed was first brought to grade and thoroughly bladed, using a Caterpillar "60" tractor and 12-ft. blade grader to pulverize the soil. After this the subgrade was cut 20 ft. wide and about  $3\frac{1}{2}$  in. deep, placing the material in a windrow on each shoulder. An application of 0.75 gal. of road oil was then applied with a trailer distributor over the 20 ft. width of subgrade and covered with 1 in. of the material previously deposited on the shoulders, using the blade grader. Then a second application of 0.75 gal. oil was applied and covered as before. This was then thoroughly mixed until the entire mass was a uniform color, using the tractor and blade to windrow the material and two maintainers to spread it out from the windrows, after which it was spread and shaped, and traffic turned on it. About three days later the third and fourth applications of oil were made and covered the same as Courses 1 and 2 and mixed in the same manner, after which the surface was ready for traffic.

As soon as a section was opened to traffic, maintainers were used to iron out the ruts and keep the surface smooth. After a few days ordinary traffic made little impression on the surface and in about two weeks' time it was smooth and firm.

A rubber-tired power maintainer was used to blade the oil-treated surface each day for about two weeks



*Rolling the Soil Stabilization Job in Motley County.*

after mixing the oil with the soil was completed. When this project started the soil was moist and broke up well, but as the work progressed it got drier and the soil broke up in clods, which increased the amount of manipulation necessary to get it pulverized. We found that sprinkling the soil with enough water to make it slightly moist not only helped in breaking up the clods, but added to the ease of mixing the oil with the soil. The sandy loam material worked better and set up easier than the extremely sandy sections. The short section on clay soil was a complete failure.

This road was oil treated only 20 ft. in width and most of the failures have been on the edges. A wider section, possibly 24 ft., would have been more desirable.

#### **Conclusions on Construction Procedure**

On future construction more attention should be given to thorough pulverizing the soil. This can be done by sprinkling, discing and rolling after the roadbed has been scarified and before the material has been bladed out on the shoulders. Use of a disc harrow for this would probably result in a material reduction of the use of the blade grader. The use of a roller, preferably one with pneumatic tires, should compact and stabilize the surface much sooner than it can be done by traffic alone, especially on the edges. Especially is this noticed in the town of Knox City. This little town had no pavement and the oil treatment was used through town on the main street, after which the city used the same methods to widen the surface to the curb line on each side, and this city section is now in better condition than any other part of the road—in fact, it has the appearance of an asphalt concrete surface. A small amount of sandy gravel had previously been placed on about four blocks of the main street in the town of Knox City. This project is now two years old and is in very satisfactory condition. No excessive maintenance has been required. Some places where too much oil was used, or, rather, where the oil was not mixed with enough sand, the surface was rolled under traffic and became waxy. Such sections have been bladed out and reshaped, adding enough sand during the operation to cure this oily condition. On a few places which were deficient in oil the same procedure has been followed except oil was added to get the proper mixture. During this last operation we have, when extra material was needed for patching on the edges, mixed an excess of material which was windrowed to the shoulder after the roadbed was reshaped and then stock-piled for future use. It is the present intention to go over the edges of this road occasionally with a rubber-tired roller, as an item of maintenance, in an effort to keep them in better condition.

#### **Equipment**

The equipment necessary for a similar job would be a Caterpillar "60" and 12-ft. blade, two self-propelled tandem drive maintainers, three trucks with booster tanks, one distributor, one scarifier, one rubber-tired roller, Caterpillar "30" and one disc harrow. Booster tanks can be used for sprinkling. This equipment can handle one 10,000 gal. car of oil per day. A heating plant and asphalt pump is needed for heating and unloading the oil. In case cut-back or emulsified asphalt is used, the same equipment would apply.

The first two miles of this project were built under the supervision of Mr. W. J. Lewalling, working out of the Austin office at that time. The balance of the project was built under the supervision of Mr. W. C. Hagan, Junior Resident Engineer in this Division.

It is my opinion that this type of construction will prove satisfactory on sandy loam soils, if traffic is not too heavy. Traffic on this road is about 600 vehicles per day, and I believe it could stand as much as 1,000 vehicles per day with little increase in maintenance costs.

#### **THE ARBA CONVENTION**

"Highways of Tomorrow" will not only be the keynote of the ARBA Highway Exhibit in San Francisco, Cal., March 7-10, 1939, but will also play an equally important role in the Convention sessions. The nation's outstanding highway authorities will participate in a program that will cover a wide range of highway activities. Future highway needs of the nation will be given special consideration with a view to determining the demand for super-highways and the economic possibilities of constructing a modern highway system.

The timely and important subject of soil stabilization will be featured at one of the sessions and highway safety will come in for a large share of discussion. The ARBA Committee on Elevated Highways will present a detailed report dealing with the pertinent problem of relieving the serious traffic congestion in metropolitan areas, which study they have been engaged in for the past two years. County officials and engineers will find the sessions dealing with the importance of the secondary road program and the new methods of mixed-in-place construction and other types of low-cost roads of particular interest. Belt-line highways or bypasses will receive a full share of consideration. Other subjects on the convention program will include highway legislation, financing and administration.

Particularly large delegations from the eleven Western States and Texas are expected to be in attendance at the convention sessions and at the display booths of the exhibit. A particularly large contractor attendance is predicted, since the annual convention of the Associated General Contractors of America is being held in conjunction with the ARBA conclave.

**TAX DIVERSION PROHIBITED BY THREE STATES**—At the Nov. 8 election in three states, California, Michigan and New Hampshire, the voters, by heavy majorities, approved constitutional amendments definitely prohibiting diversion. A similar amendment failed of adoption in Alabama by fewer than 3,000 votes. Colorado, Kansas, Minnesota and Missouri already have amended their constitutions forbidding diversion of highway funds for other purposes.

# OBSERVATIONS BY THE WAY

By  
**A. PUDDLE JUMPER**



☛ The out-of-the-ordinary is always interesting. A few months ago, part of U. S. 21, near Dexter City, Ohio, was destroyed by a slipping hillside. The dirt, rocks and debris covering the road had to be removed and a new sub-grade laid for repaving. To rem-



edy the drainage problem which apparently caused the slide and to help support the hillside, the engineers designed a toe trench to be constructed at the foot of the hill. This was filled with one-man rock to handle the seepage and drainage ditches dug from the toe trench to lower ground. These pictures show the work exceptionally well. A tractor and scraper are shown digging the toe trench. Because of its ability to draw in its own slope, the scraper was able to dig this deep ditch without additional help. In the same picture, the old



grade is seen in the upper right hand corner and the slipped material in the foreground. The second picture shows an angled dozer cutting a drainage ditch from the toe trench. In both cases, old gas tractors were put back into the profit column and used to do the unusual job. Adams Brothers, of Zanesville, Ohio, are the contractors.

☛ How Michigan prepares for slippery, ice or snow covered hills and curves is shown by this picture taken between Kalamazoo and Lansing. This grit stock pile is covered with flake calcium chloride. These stock piles are spotted frequently. I also noticed barrels of grit along the



shoulder on heavily travelled U. S. 12 for the motorist to serve himself cafeteria style, if needed.

☛ How about putting a little pressure on the National Park Service to get that road from Tioga Pass, in Yosemite National Park, over to the valley (East to West) improved next year? That's certainly a tortuous trail.

☛ What a mess has developed in Ohio because of political pressure in highway engineering.

☛ The work that bulldozers can do

is astounding. Here Burke Bros., contractors of Portland, Oregon, are raising and widening U. S. 101 just south of Coquilla, Oregon. Just



south of Wickenburg, Ariz., on the main road to Phoenix I saw a bulldozer gouging rock like this out of a cut. They're a powerful tool.

☛ And Felix, the office boy, claims that the difference between the poor hunter and the constipated owl is that the poor hunter shoots and shoots but never hits.

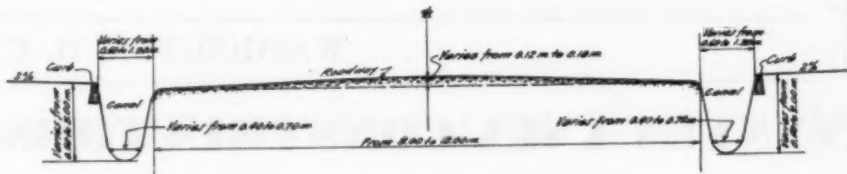
*From the Montana "Center Line."*

☛ The picture herewith was taken on U. S. 30 in Indiana. It's the first major accident I saw as a result of the snow storm after Thanksgiving. Were it not for the presence of the cable guard rail, the accident would have been much more serious. Guard



rails may not be things of beauty, but in cases of this kind—"good old cable."

Mr. Jose G. Licuanan in the Department of Engineering and Public Works sent the cross-sectional diagram shown herewith as indicative of the type of streets in a certain sec-



TYPICAL CROSS-SECTION  
MACADAM STREET

tion of Manila, P. I. Note that the curb is on the outside of the ditch. Also note the depth of the ditches. Mr. Licuanan is looking for a self-loading machine that will clean out or dig these ditches.

At the recent Fall meeting of the Board of Directors of the Associated General Contractors the W.P.A. was under fire. They're not alone when it comes to taking pot shots at W.P.A. Anyhow, the story was told that London Bridge was built by day labor. Shortly after it was finished it began to fail. That's how come the song, "London Bridge Is Falling Down." Even a nursery rhyme is an argument against W.P.A.

At this same meeting at the dinner one night Chief Engineer Nuss of Kansas led a lilting lullaby accompanied by D. H. Hardman, M. W. Watson, John Harbes, and Sam Rudder as follows:

"I don't suppose we'll do it again,  
"For months and months and months.  
"We did it only yesterday and  
"We did it only once.  
"I don't suppose we'll do it again,  
"For months and months and months."

I wonder what they meant by "it"?

Who said Abie (Nuss) knew how to sing?

At this same contractor's meeting H. K. Bishop, construction engineer, U. S. Bureau of Parallel Ruts, said he found a contractor who read the specifications. He's got him on ice.

Not to be outdone at this same meeting, Tony (A. E.) Horst, contractor (now of Philadelphia) inferred a side light on specifications when he asked why a black cow gave white milk. The answer was—probably because blackberries are red when they're green.

Ho Hum! These wise cracking contractors. Ask Bill Klinger, contractor of Sioux City, Ia., and past president of the A. G. C., to tell you the story about Nero and the Appian

Way. It sounded a whole lot like story of the government and W.P.A.

Toastmaster Bishop was introducing Mr. Watson, a contractor from Kansas, who was formerly an engineer. I felt sorry for Watson. Bishop put him on a spot. He said the building contractors claim Watson is a highway contractor and the highway contractors claim he's a building contractor. What a rep this guy Watson must have.

Old Dobbin went to work again on Kingshighway No. 21 between Goderich and Kincardine, Ontario, recently. In justice to Canada I must



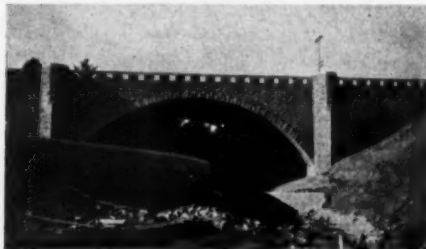
state that the operator told me they also used powered equipment. This was an "economy" measure. The gravel surface was in good condition.

And here's one for this month. A cow stood 5 ft. from the center of a railroad bridge when she spied the Western Express just twice the length of the bridge from the entrance. The train was going at the rate of 90 miles an hour. This wise cow did not waste a fraction of a second in idle speculation. She dashed straight for the train, got off the bridge in time, saving herself by the narrow margin of one foot. However, if she had followed the human instinct of running away from the train, three inches of her rear would have been caught on the bridge. What was the length of the bridge?

From the Montana "Center Line."

Saturday after Thanksgiving I headed East to Washington, D. C. I drove late at night both Saturday and Sunday. Will the chief engineers of Ohio (on the road from Columbus to Marietta), West Virginia and Maryland (on U. S. 50) send letters of commendation to their loyal, energetic, courteous and cooperative snow plowing and grit spreading crews? During the stormy and icy weather they worked way past midnight keeping the roads open. My hat is off to these steady workers. If a truck or car was unfortunate enough to have slipped off the road surface, they hooked on and courteously helped them on their way.

Beautiful stonework was done by John C. Fisher, contractor from Cleveland, on this curve and hill elimination project on U. S. 2 and 6 about



10 miles west of Cleveland. The wall in the foreground carries a road into Huntington Beach beneath U. S. 2 and 6.

While speaking about Michigan, I cannot help but criticize their horse-and-buggy signing system. It's N. G. Why not modernize your signing system this year, Pat?

The tax on gasoline and oil is the foundation of highway revenues. The next time you fill your tank, remem-



ber you are paying for roads you don't get as long as diversion continues unabated.

INTERESTING AUTOMOTIVE  
DATE

1892—First gasoline automobile in  
America. Charles Duryea's  
"Buggy aut."

# American Road

WASHINGTON, D. C.

## ASSOCIATED PENNSYLVANIA CONSTRUCTORS

### Down the Road

By CHARLES M. UPHAM

Engineer-Director,  
American Road Builders' Association, Washington, D. C.

#### CHRISTMAS: 1900—1938

"Jingle bells, jingle bells, jingle all the way,

Oh, what fun it is to ride in a one-horse open sleigh!"

... and indeed it was fun to start off for a real old-fashioned Christmas. Those of you who look back to a childhood at the turn of the twentieth century can remember the thrill of expectation with which you looked forward to the Yuletide. The eagerness with which you hung your stocking by the fireplace on Christmas Eve. The unalloyed joy with which you found that Santa Claus had not forgotten you on Christmas morning. In those days an orange in the toe was a real treat. Families were bigger and more clannish forty years ago. Aunts, uncles, cousins and grandchildren all gathered for Christmas dinner at "grandma's house." From miles around they drove in buggies, in coaches and in sleighs behind prancing horses over the fields of glistening snow. The table groaned with turkey, mince pies, plum puddings and all the delicacies of the season. The house rang until late at night with chatter of grownups and the merry cries of children. The evening was not complete until the voices of young and old alike had joined in the well-known and well-loved Christmas carols.

That is the picture of Christmas in 1900. Christmas, 1938, will be the same in all the real essentials. In America, at least, it is still a season of "peace on earth to men of good will." To most Americans, Christmas is still "a family affair" and Christmas cheer is measured by the number of loved ones we have near us on that day.

When these loved ones gather this year, however, their mode of transportation will be greatly changed from that used in the day of the first Roosevelt. The 1938 version of the one-

horse open sleigh is a seventy horsepower, streamlined automobile. Our grandfathers liked to think of themselves as "dashing through the snow" at 8 or 15 miles an hour. Modern drivers "dash" only when they attain a speed of 60 or 70 miles. The candles on our Christmas trees have been replaced by strings of electric light bulbs. Most of our Christmas carols come over the radio.

Speed and progress are the watchwords of 1938. The speed and progress which can be claimed by the automotive industry, however, unfortunately do not have a counterpart in our highway system. The road over which grandfather drove his horse and buggy in 1900 is all-too-similar to the road over which grandson is attempting to safely steer his horseless carriage in 1938. The road which was built for a comparatively few vehicles two score years ago must today, with only slight improvements, carry many times that number. Runaway horses caused many of the most serious accidents in 1900. Serious and fatal accidents today are often caused by faults in our highways, even though the driver may have perfect control of his vehicle.

But this is the Christmas season. It is the season of happiness and joy and no time for recalling our narrow, crooked roads and crowded highways. It is the time to think of giving and receiving, not the time to recall our steadily mounting rate of highway-accident fatalities. So let us rejoice in our Christmas trees, our Christmas gifts and our Christmas turkey. Let us rejoice most of all in our loved ones and in their ride in safety over the road which brought them home on this "day of days."

Merry Christmas and Happy New Year.

#### ASSOCIATED PENNSYLVANIA CONTRACTORS TO MEET IN DECEMBER

The Associated Pennsylvania Constructors will hold their annual convention and banquet at the Penn-Harris hotel in Harrisburg, December 15-16. More than 500 guests are expected to attend the banquet and several prominent highway authorities have been expected to speak. The stage show which has always been a feature of the occasion in the past will again be presented at this year's conclave. A cordial invitation to this convention and banquet is extended by the Pennsylvania association to all members of the ARBA. Arrangements are now under way for the adoption of "Highway Builder," APC organ, as the official publication of the Pennsylvania Stone Producers' Association which represents 80 per cent of the crushed stone industry in that state. Future issues of this magazine will devote a special section to notices for the PSPA and articles of special interest to this group will be included.

#### PAUL REINHOLD ADDRESSES VIRGINIA ROAD GROUP

Paul B. Reinhold, vice-president of the American Road Builders' Association, spoke on diversion of motor-vehicle revenues at the opening-day banquet of the annual convention of the Citizens' Road League of Virginia in Roanoke, October 27-28. W. C. Snee, assistant engineer-director of the ARBA, also addressed the meeting on national highway legislation. The convention was attended by approximately 225 road-minded Virginians.

#### STATE HIGHWAY DEPARTMENTS ARBA GROUP MEMBERS

The state highway departments of Oklahoma, Texas, Kentucky, West Virginia, Georgia, North Dakota and Wyoming have recently applied for group membership in the American Road Builders' Association.

A committee of fifteen of the nation's leading road builders met last month in Washington to discuss with WPA officials the possibility of working out a plan for incorporating WPA highway work into the contract system.

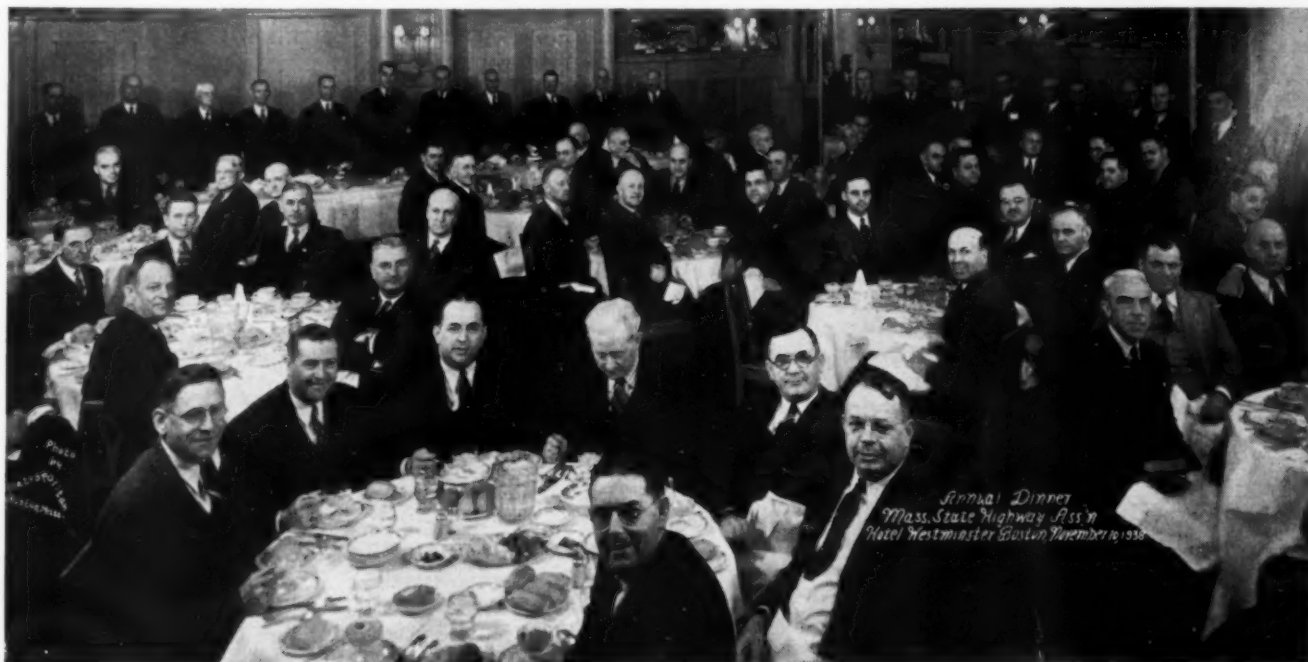
# Builders' Review

DECEMBER, 1938

Merry Christmas  
and  
Happy New Year

**SCHEDULE ANNUAL MEET DECEMBER 15-16**

## With Our State Groups



*Annual Dinner  
Mass. State Highway Ass'n  
Hotel Westminister Boston November 10, 1938*

Shown above are the eighty persons who were in attendance at the annual dinner of the Massachusetts Highway Association in the Hotel Westminster at Boston on November 10. The group heard George H. Delano, chief engineer of the Massachusetts department of public works, discuss flood and hurricane conditions. Shown in the picture are, third from the left, Professor C. Frank Allen, Massachusetts Institute of Technology, retired, president of the road organization in 1898; fifth from the left, Mr. Delano; sixth from the left, James A. Knowlton, president of the Massachusetts group, with W. C. Slee, assistant engineer-director of the ARBA, on his right, and John M. McCarthy, secretary of the state association, second from the end. Frederick Hoitt, secretary, New England Road Builders' Association, is seated second from the left at the table directly centered in front of the speakers' table.

### SHERLOCK BECOMES CHIEF ALABAMA HIGHWAY ENGINEER

C. J. Sherlock, Jr., a member of the board of directors of the American Road Builders' Association, has succeeded H. H. Houk as chief state highway engineer of Alabama. Mr. Sherlock, who has been associated with the state highway department for fifteen years, was formerly assistant engineer. Mr. Houk resigned to accept the post of consulting engineer with the Civil Aeronautics Authority at Washington, D. C.

### ARBA DIRECTOR HONNEN TO ADDRESS COLORADO MEET

"The Economics of Construction Machinery Operations and Simple Cost Accounting Methods" will be discussed by Edward H. Honnen, president of the Colorado Association of Highway Contractors, at the 1939 annual highway conference of the University of Colorado. Mr. Honnen, who has been engaged in the contracting business since 1919, is a member of the board of directors of the ARBA Highway Contractors' Division.

### ARBA OHIO DIVISION PLANS LEGISLATIVE ACTION

The Ohio Division of the American Road Builders' Association met on November 17 to outline the association's legislative program for the coming year. The group expects that the results of the November elections will insure full co-operation between the executive and legislative branches of the state government toward securing the return of the bid and contract system for road work.

# A METHOD for the QUANTITATIVE DETERMINATION OF OILY CONSTITUENTS IN ROAD OILS OF THE SLOW CURING TYPE

By M. ROSUMNY and A. de ROSSET

Laboratory of the State Highway  
Commission of Wisconsin

*The available types of solvent-adsorbent analyses for bituminous materials have not given consistent results when applied to road oils. The factors affecting the determination of the oily constituents are discussed and several refinements in technique suggested. A procedure for the determination of oily constituents is outlined which gives checks of an order of accuracy of 1%.*

*The method of analyses presented in the following article has been used by members of the Wisconsin State Highway Commission staff as a basis for studying behavior of asphalts of the slow curing type. Reports of such studies are to be released at later dates.*

**A** RELIABLE scheme of chemical analysis for road oils is much to be desired; first, because the analytical data may distinguish between source and refining process of the oil; second, correlation with service durability may be possible; finally, such a scheme enables the investigator to trace changes in the oil in the course of weathering cycles without recourse to physical tests.

While many types of chemical analysis are available, that most generally applicable to bituminous materials is one based on selective solvent and adsorbent action. Fractions such as asphaltenes, resins, oily constituents are obtained. Various specific techniques have been proposed by Marcusson,<sup>1</sup> Streiter,<sup>2</sup> Maas<sup>3</sup> and others.<sup>4,5</sup> The general procedure is to precipitate from the bituminous material matter insoluble in selective solvents such as naphtha, ether, or hexane; to refine the filtrate on an adsorbent such as charcoal, silica gel, or Fuller's earth; and recover the oily constituents from the adsorbent by extraction with one of the above selective solvents. The resins remain behind on the adsorbent.

Marcusson uses 88° Be. petroleum naphtha as a solvent and Fuller's earth as an adsorbent. After extraction with naphtha to remove the oily constituents, he makes an extraction with carbon disulfide to determine the resins. The two fractions are recovered from solution by evaporation to dryness at 100°.

Streiter uses ethyl ether as solvent and a mixture of Fuller's earth and silica gel or clean sand as an adsorbent. He specifies a three-hour period of extraction of the oily constituents from the adsorbent. Resins are determined by extracting for three hours with chloroform or carbon disulfide.

Maas proposes two independent precipitations, one in petroleum ether and one in an alcohol-ether mixture. The filtrate from the former is used for the determination of oily constituents. The adsorbent is a mixture of

Fuller's earth and woolly asbestos. Extraction is carried out for eight hours, and the oily constituents recovered by evaporation at 105° C. Resins are determined by difference.

This laboratory, in attempting to apply the methods of Marcusson, Streiter, and Maas to the analysis of road oils of the slow curing type has been unable to obtain check results in the determination of oily constituents. While the third method is satisfactory in dealing with distillation or evaporation residues, it has become evident that in dealing with the original oil, certain modifications of technique and standardization of experimental conditions are necessary.

The factors influencing the determination may be summed briefly and then considered in more detail. They are (1) the solvent used for precipitation and extraction; (2) the nature and activity of the adsorbent; (3) the time and rate of extraction; (4) the method of recovery of the oily constituents from the solvent.

## Solvent

The solvent to be used in an analysis such as this must be selective. It must not be preferentially adsorbed, or it will displace the resins from the Fuller's earth. It should be reproducible, either by specification or known identity. It is technically desirable that the solvent be reasonably safe and not too unpleasant to work with, and that its boiling point be convenient for extraction work.

Hexane answers the first two requirements very well. Its solvent action is selective, and being a straight chain saturated hydrocarbon it is not preferentially adsorbed as is alcohol. Unlike petroleum ether or naphtha, its chemical identity, with the exception of impurities and isomeric forms, is fixed. While ethyl ether is possibly more satisfactory in this respect, hexane is much safer to handle than ethyl ether, and the impurities and isomers may be controlled by specification.

The hexane used in this laboratory meets the following specifications:

I. B. P. ....	64° C.
Boiling range .....	64°-70° C.
Aniline number .....	139°-140° F.

As received from the manufacturer it also showed the following characteristics:

Surface tension at 25° C. ....	17.6 dynes/cm.
Refractive index at 25° C. ....	1.3810
Bromine adsorption value. ....	11 mg. per gram

The hexane should be free of residual oils.

## Adsorbing Agent

The adsorbing agent used in this laboratory is Fuller's earth obtained commercially as "Fuller's earth, C.M. No. 338-1." Supplies of this material can be duplicated by specifying a hydrometer sedimentation test and chemical analysis. Table I and Fig. 1 illustrate sedimentation characteristics. Table II summarizes chemical tests.

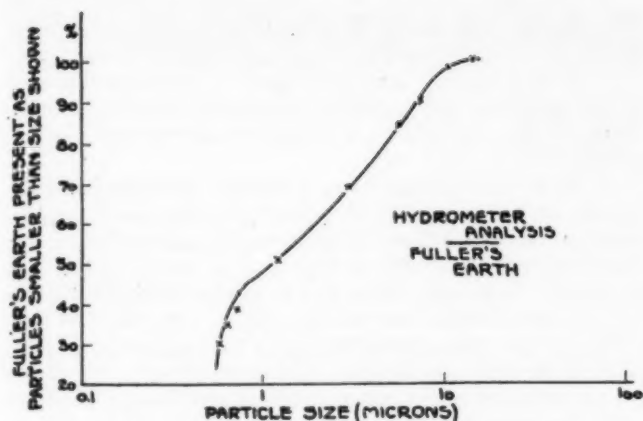


Fig. 1.

TABLE I

Particle Diameter (Microns)	Per Cent Adsorbent Present as Particles Smaller Than Given Diameter
17.8.....	100
10.4.....	98
7.5.....	90
5.5.....	84
2.9.....	69
1.2.....	51
0.7.....	43

About 50 per cent of the material is present as particles less than 1 micron in diameter.

TABLE II

	Per Cent
Silica .....	44.89
Aluminum oxide .....	3.83
Titanium oxide .....	1.43
Calcium oxide .....	0.26
Iron oxide .....	0.73
Combined water .....	13.38
Moisture content .....	0.65

Samples from several sources were studied by (1) an absorption test based on the chromatographic principle, and (2) a comparative test of absorption characteristics using the same oil. The sample (C.M. No. 338-1) which gave the highest absorption was chosen for the work.

The adsorbent power of this material varies according to its state of activity. An adsorbent is usually activated by maintaining it at considerable temperature for a

period of time, preferably in a vacuum. The following table shows the determination of oily constituents in a road oil using Fuller's earth of varying degrees of activity:

TABLE III

Treatment of Fuller's Earth	Per Cent Oily Constituents
1. Used as obtained from manufacturer.....	80.5
2. Heated at 160° C. for 24 hrs., cooled in laboratory air.....	78.2
3. Heated at 160° C. for 24 hrs., cooled in vacuum.....	75.7

It is seen that the amount of material (i.e., oily constituents) removed from the adsorbent by prolonged extraction decreases as the adsorption power of the Fuller's earth is increased by activation. Hereafter in this paper activated Fuller's earth will be taken to mean Fuller's earth which has been subjected to treatment 3.

### Time and Rate of Extraction

To obtain check results in the determination of oily constituents it is necessary that the extraction process be standardized, that is the oils should be extracted at a uniform rate for a specified length of time. To obtain a uniform rate of extraction in a bank of Soxhlet extractors this laboratory uses 75-watt lamps enclosed in a cylindrical asbestos shield impregnated with sodium silicate. The extraction flasks rest directly on the lamps, fitting snugly into an asbestos cover plate which completely closes the gap between the flask and lamp shield. The Soxhlet extractors are of the large type (110 mm, height of syphon; and 50 mm, diameter) and are used with 250 cc. extraction flasks. With the above set up, one extraction was made every half hour.

The extraction should be carried out until little or no more oil is carried down by the solvent. The best method for determining complete extraction is to make the analysis with longer periods of extraction until no increase in percentage of oily constituents is observed. This has been done for three road oils and the data given in Table III. They are plotted in Fig. 2 on a reciprocal scale whereby one can extrapolate the curves to infinite time and observe the theoretical limit.

TABLE IV

Oil	Time of Extraction (Hours)	Per Cent Oily Constituents (with Average Deviation)
A .....	10	68.6 ± 0.6
	12	69.7 ± 0.3
	16	70.0 ± 0.5
B .....	10	69.9 ± 1.2

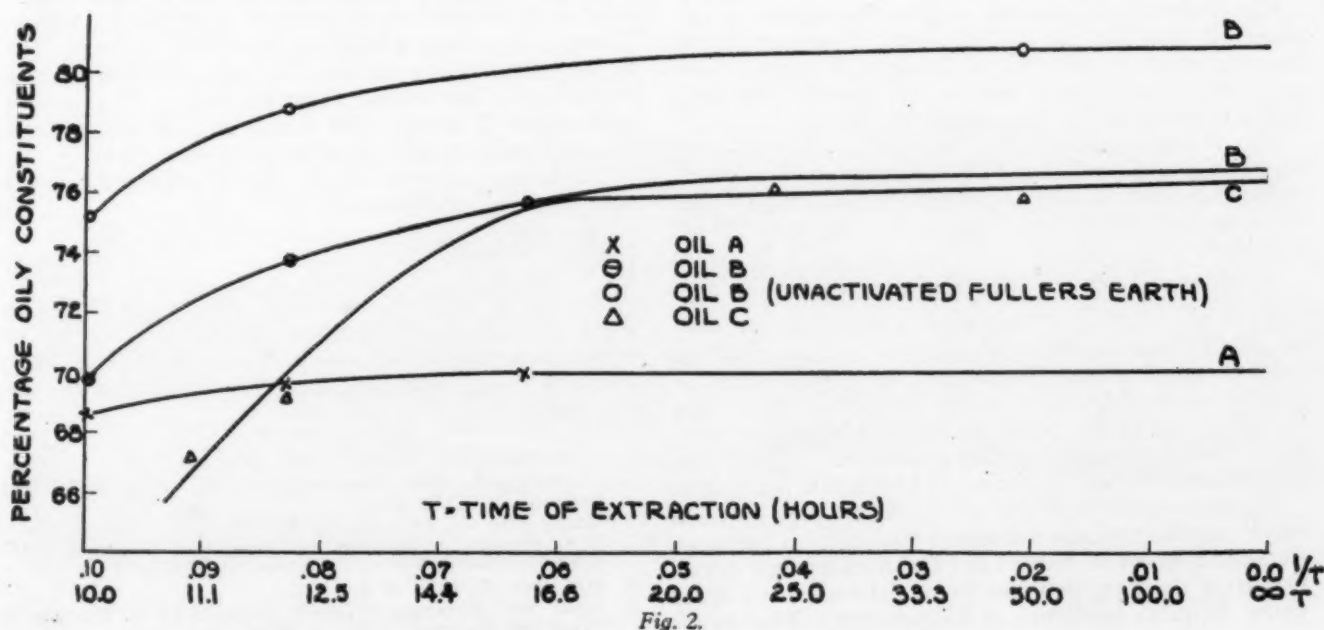


Fig. 2.

	12	73.8 ± 0.4
	16	75.7 ± 0.9
C .....	11	67.2 ± 0.3
	12	69.4 ± 0.1
	16	75.8 ± 0.3
	24	76.2 ± 0.6
	48	75.9 ± 0.8

Each determination is the mean of three concurrent results. One can also see, referring to Fig. 2, the effect of activating the Fuller's earth as discussed in the last paragraph. The top curve was developed using the adsorbent as supplied by the manufacturer. The one directly beneath was developed using activated Fuller's earth. The increase in adsorptive power is clearly marked.

### Recovery of Oily Constituents from the Solvent

The method formerly used to recover the oily constituents from the solvent, following extraction, was to evaporate the solution nearly to dryness and drive off the remainder of the solvent by heating at 105° C. for 15 minutes. This method has two objectionable features. First, it is questionable if all the solvent is removed. The samples often continued to lose weight after standing in the open air over a period of time. Furthermore, the refractive indices of the oils so obtained were not consistent, varying in the case of oil B all the way from 1.5090 to 1.5140. The percentages obtained varied roughly with the refractive indices. This may be due to the persistence of solvent.

In the second place the method of hot evaporation may affect the nature of the oil: liquid asphaltic materials contain volatile fractions which may possibly be driven off at this temperature. Further, oxidation or other chemical reactions may take place. In the case of oil B, the oily constituents had a viscosity of 5.5 poises when the method of hot evaporation was used, as compared to 2.3 poises when the more satisfactory method to be described was used. Also, heating in the oven gives the oils a reddish tinge and a gummy appearance. Hence, this laboratory adopted the practice of evaporating the oil nearly to dryness in a tared beaker, placing it in a vacuum desiccator, and evacuating to 2 mm. pressure, room temperature, at which point the pump is cut off and the sample is allowed to reach constant weight; this usually takes about twelve hours. It is, therefore, convenient to allow the oils to remain in the desiccator overnight.

The attainment of constant weight, the thinness of exposed oil film and the boiling point of hexane at the pressure used (−46.9° C. at 2 mm. pressure) were taken to be sufficient to assume the hexane was sufficiently removed to become a negligible factor.

The oil thus obtained is less viscous than that obtained by the former method. The refractive indices check closely. In the case of the aforementioned example the variation was reduced to a range varying from 1.5090 to 1.5100.

### Accuracy of the Determination

Since the experiments described in this paper were intended to study the effect of a variety of factors on the determination of oily constituents, a large number of exactly comparable results is not available. In the case of oil C a set of 11 results for various lengths of time, but essentially constant within experimental error, give a mean and standard deviation of  $75.9 \pm 0.9$  per cent.

However, each determination is the average of three check samples, and the average deviation from the mean for each is given in Table III. The final average deviation from the mean for any set of determinations made under identical conditions is 0.7 per cent. This means

that the average range for say three samples is about 2 per cent. Typical results obtained with the former procedure used by this laboratory gave an average range of 5 per cent for three samples run under the same conditions. This represents a considerable increase in accuracy.

It must be re-emphasized, however, that precision depends on care used in standardizing the conditions of analysis and on a consideration of the particular oil being studied. Referring to Figure 2, it is seen that Oil A is almost completely extracted in twelve hours, while Oil B requires twenty-four hours. Oil C acts like Oil B at first, but the time-extraction curve flattens out sharply at sixteen hours. Activation of the adsorbent contributes to accuracy by providing a standard condition. Undoubtedly the most useful technique found by this laboratory to give check results was the vacuum desiccator method for removal of the solvent.

### Detailed Method of Procedure for Determination of Oily Constituents

0.5 ( $\pm 0.03$ ) gram of the road oil is weighed into a tared 150 cc. beaker and dissolved as far as possible in 100 cc. of hexane. After standing one hour at 25° C. the precipitate is filtered off on a Gooch crucible, dried at 100° C., and weighed as asphaltenes. The filtrate is evaporated to about 15 cc. and thoroughly incorporated into a mixture of 25 gms. of activated Fuller's earth and 10 gms. of short-fibered asbestos. The Fuller's earth was heated for 24 hours at 160° C., cooled in a vacuum desiccator, and mixed dry with the asbestos in a beaker. The mixture of oil and adsorbent is stirred to uniform consistency, which is semi-dry, and not wet.

After the adsorbent mixture has been allowed to stand for about eight hours in the dark it is transferred quantitatively into an extraction thimble, using a little hexane to wash the beaker if necessary. The thimble is then plugged with a wad of long-fibered asbestos and extracted in a Soxhlet extractor with hexane for sixteen hours, or until the oily constituents are completely extracted, as determined by trial runs. The rate of heating, the size of the extractor used, and the rate of cooling, are adjusted to produce one extraction every half hour.

The extract is filtered through a Gooch crucible to remove particles of asbestos. The filtrate is then evaporated to 25 cc. and transferred to a tared 100 cc. beaker. There it is further evaporated nearly to dryness. The beaker is placed in a vacuum desiccator and evacuated to 2 mm. until it has reached constant weight. This usually takes about 12 hours. The beaker is then weighed and the percentage of oily constituents is determined.

The hexane used in making this determination meets the following requirements:

Initial boiling point.....	64° C.
Distilling between .....	64° and 70° C.
Aniline number .....	139° F./140° F.

On the basis of repeated trials over a period of two years this laboratory proposes the aforementioned procedure as a dependable analytical method for the determination of oily constituents in road oils of the slow curing type.

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# MODERN HIGHWAY OFFICE BUILDING

By RALPH C. HARRIS

*Highways Architect, State of Illinois*

**T**HE State of Illinois has recently completed the construction of a building at French Village (near East St. Louis) for use of its District No. 8. This is the fourth building of this type completed by the state. The three buildings built previously are those located at Effingham, Dixon and Peoria.

## Building Result of 5 Years' Study

The state of Illinois, for highway administration purposes, is divided into ten districts, each district consisting of from 10 to 12 counties, each having under its control approximately 1,500 miles of highways and 100 bridge structures. The activities of each district, so far as administration, maintenance and new construction are concerned, are so complex that the need of specially designed buildings has long been felt. The first building of this type was erected at Effingham in 1932; the second one in Dixon in 1935 and the third one in Peoria in 1937. The newest one, that in French Village, therefore represents the result of five years of study as to the needed requirements of these district buildings. The building has been occupied since June of this year and, to date, no major errors of design or construction have come to light. In other words, the state feels that the French Village Building represents an extremely good solution to an extremely complicated problem.

The site for the building is approximately five miles east of East St. Louis, at the edge of a small village, the population of which is not more than 200, and is located on one of the main arteries of east and west

traffic, U. S. Route No. 50, near the intersection of that route with the north and south Illinois Route No. 157.

## The Location

As a tract consisting of approximately seven acres was needed for the purposes of the building, it is obvious it would be impossible to secure this site within the limits of East St. Louis. In addition, the large amount of truck traffic centering at the building made the location of the building within a city undesirable. On the other hand, the activities of this district are largely centered in the metropolis area of East St. Louis and it was, therefore, essential that the building be located as near as possible to that point. The site selected seems to answer all requirements. It is close enough to East St. Louis to provide adequate housing for employes and proper maintenance service, but it is far enough away to eliminate additional traffic problems. Being at the junction of two main highways, it is conveniently located for circulation throughout the district. Employes find little inconvenience due to its distance from East St. Louis and find a great deal of pleasure in working away from the noise and dirt of a city.

## The Building

The site itself, comparatively level, has been landscaped with great care. The development consists of a main building which houses the highway offices, the state police offices, the district garage, the district sign shop, the district materials laboratory, together with district supply departments. In addition, there is a



*Kaufmann-Fabry Photos*

*The New \$250,000 District Highway Office Building at French Village Near East St. Louis, Ill.*



Kaufmann-Fabry Photos

*Interior of Lobby. Note Photomural Decorations.*

storage building designed to accommodate cement, paint, road equipment, road materials, etc., and a storage yard for the bulk storage of sand, gravel, stone and other equipment that need not be kept under cover. A large service parking area is provided for employees, all of which area is fenced in for the protection of employees' cars. The district offices occupy the second floor, over one portion of the building, the lower floor being devoted to the garage, laboratory and police headquarters.

The exterior of the building is functional in design and presents an extremely streamlined appearance. Materials used consist of light buff brick and Bedford stone, combined with green and cream colored terra cotta bands. Horizontal lines are accented even to the extent of having horizontal stripes on awnings. The main entrance feature reverses the horizontal tendency and accentuates vertical lines. The feature of the main entrance is the large glass block panel surmounting the aluminum entrance doors.

The exterior is lighted by indirect reflector lighting over the glass panel and in addition, is floodlighted from two ornamental stone pylons which contain the floodlights.

The building is of fireproof construction with the exception of the garage roof, which is of wood construction supported on steel trusses. The frame of the building is of concrete mixed in accordance with the state highway specifications which employ the mortar void method of proportioning. All exposed surfaces of concrete are carefully rubbed and represent a good example of highway concrete work.

### Highway Offices

The district offices, situated on the second floor, occupy about 8,000 feet of floor area. Private offices are provided for the district engineer, assistant district engineer, construction engineer, maintenance engineer, materials engineer, county roads engineer and design engineer. The general offices are designed to accommodate 60 employees and the drafting room is designed to carry a peak load of 40 men. Provision has been made so that the general offices, or the drafting room, may be increased or decreased in size as conditions may require by the changing of a single partition.

The entire second floor (as well as the police head-

quarters section on the first floor) is completely air conditioned. This air conditioning is accomplished by means of a central plant located on the lower level, air being either heated or cooled, washed, humidified or dehumidified and distributed by means of metal ducts. Circulation is obtained by the installation of a properly designed exhaust system, thus insuring a system of fresh air supply at all times. With the single exception of a fire escape opening on the second floor, no windows throughout the second floor can be opened and employees cannot disturb the proper functioning of the air conditioning system by unnecessarily opening windows.

### Police Offices

The offices of the state police district maintained in this area are also housed in the building. These offices are located on the first floor and are so arranged as to be entirely separated in all of its functions from those of the district offices. Police offices consist of private offices for the use of the lieutenant and sergeant, together with space for police clerks and a public reception space. The police headquarters is provided with its own sanitary facilities, storage rooms, janitor closets, etc.

There is no occasion for interference between functioning of the district offices and the police offices.

### Laboratory, Sign Shop and Garage

On the ground floor of the building is located a large materials laboratory equipped to test concrete and paint materials for the district. In addition to the laboratory, provision is made for the proper housing of materials, engineer's equipment such as scales, beam boxes, etc.

Adjacent to the garage is a paint shop for the preparation and painting of road signs. This shop consists of a cleaning room, a spray room and a paint room where signs are lettered. Signs are supplied at one end of the shop, are processed and are delivered at the other end of the shop without interference to operation of the garage. The spray room is so located that trucks can be run directly into it from the garage for truck spray painting.

The open garage portion of the building is one-story in height, 65 ft. wide and 165 ft. long. In addition to the necessary work lines, the garage contains a wash rack with hydraulic hoist and pressure washer, a grease rack with hoist, brake testing equipment, wheel aligning equipment, headlight testing equipment and other machines such as are generally needed. In addition, the garage has separate facilities for motorcycle storage and repair, and a large supply room.

### Storage Building

The storage building of frame construction provides approximately 7,000 sq. ft. of covered storage space. The building is divided into separate units, each unit equipped with overhead rolling doors so that trucks may enter the same. The building is unheated and except for the cement storage portion is unfinished on the interior. The portion devoted to the storage of cement is completely waterproofed. All service portions and roads of the development are completely floodlighted so that the district can function at night as well as in the daytime.

The development of the project, including the design and construction of the building, was under the supervision of the writer. Mr. F. Lynden Smith is Director of the Department of Public Works and Buildings, Mr. Ernest Lieberman is Chief Highway Engineer and Mr. S. F. Wilson is District Engineer.

# SOIL STABILIZATION<sup>1</sup>

After C. A. Hogentogler and E. S. Barber

Senior Highway Engineer, Junior Highway Engineer,  
U. S. Bureau of Public Roads U. S. Bureau of Public Roads

Reported by VICTOR J. BROWN

Publishing Director, Roads and Streets

## PART VI

It is anticipated, even predicted by some, that the tri-axial method of testing soil samples, i.e., the use of the stabilometer, will replace shear testing before very long. At the recent Highway Research Board meeting this method was highly recommended and favorably commended. There remains the very necessary work of correlating test results with field service and practical results. Without this correlation no testing has value. Unless usable values for  $c$  and  $\phi$  can be obtained, developed theories will go for naught. This article explains the advantages of the stabilometer for determining usable values and the principle upon which it is built.—V. J. Brown.

number of theories which related to the stability of bridge piers, abutments and earth embankments. But such theories have a broader significance since they form the basis of formulas suggested for use in estimating the thicknesses of flexible type pavements. See G. E. Hawthorn (1),<sup>2</sup> Bernard Gray (2), W. S. Housel (3), and A. C. Benkleman (4).

The article in the May issue called attention to the desirability of expressing shear test results by means of stress-strain curves; and typical examples were shown in Figs. 20 and 21, page 37. Similar material has been reported in the October Bulletin, A. S. T. M. (5); and an illustration from that report is reproduced here as Fig. 1.

**D**IRECT shear tests, the resulting data, and their application in design was discussed in the May issue of ROADS AND STREETS. Included were a

<sup>1</sup>From Subgrade Soil Exhibit of the U. S. Bureau of Public Roads, at the 1938 Convention of the A. R. B. A., and a paper entitled "Trend of Soil Testing," presented at the 18th Annual Meeting of the Highway Research Board.

<sup>2</sup>Numbers in parentheses ( ) indicate references listed in the bibliography, included at the end of this article.

Such relations are essential if shear test data are to be used in connection with the design of flexible type pavements also, because of two stabilized soil mixtures which have equal ultimate shear strengths, one might have to rut to a considerable depth before its ultimate strength is reached, whereas the other might reach maximum shear resistance at an inappreciable deformation.

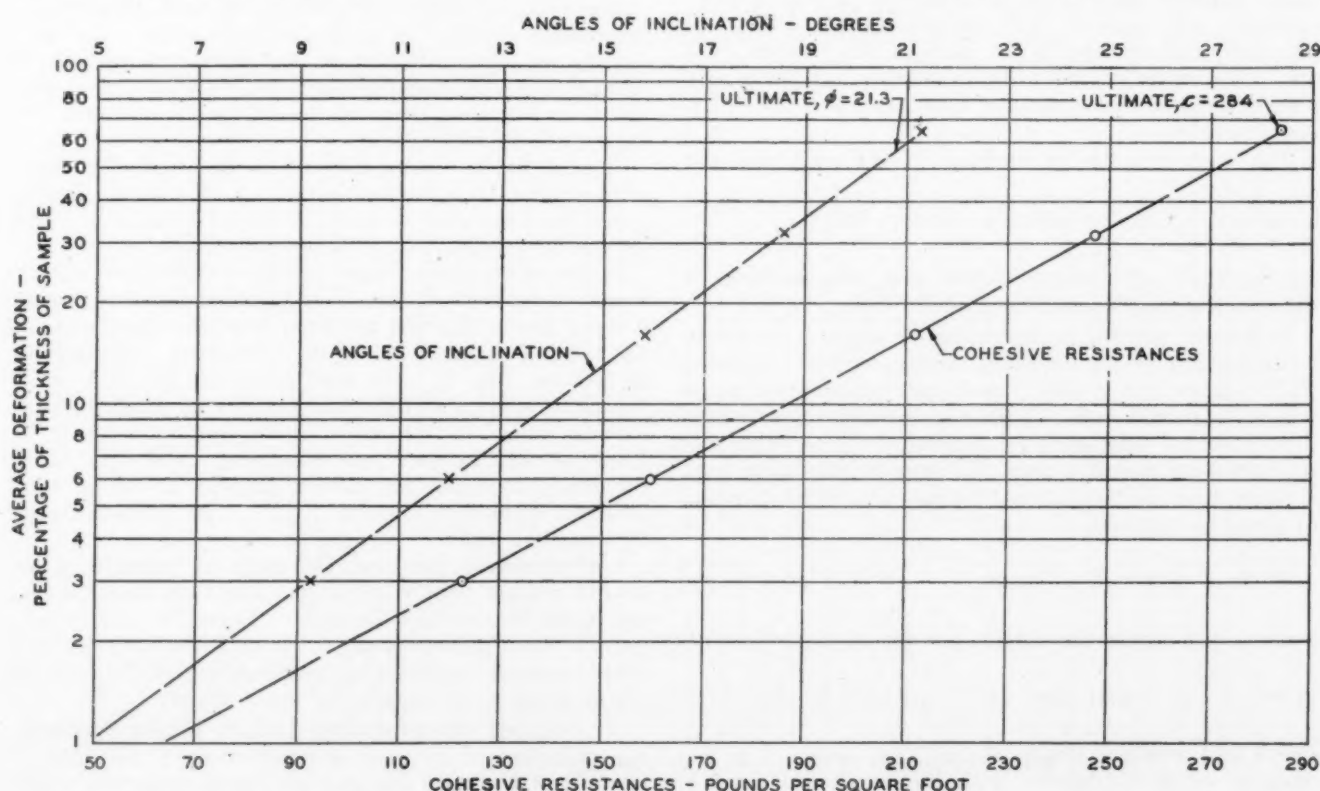


Fig. 1.—Relation of Sample Deformation to Shear Constants Obtained in Shear Tests.

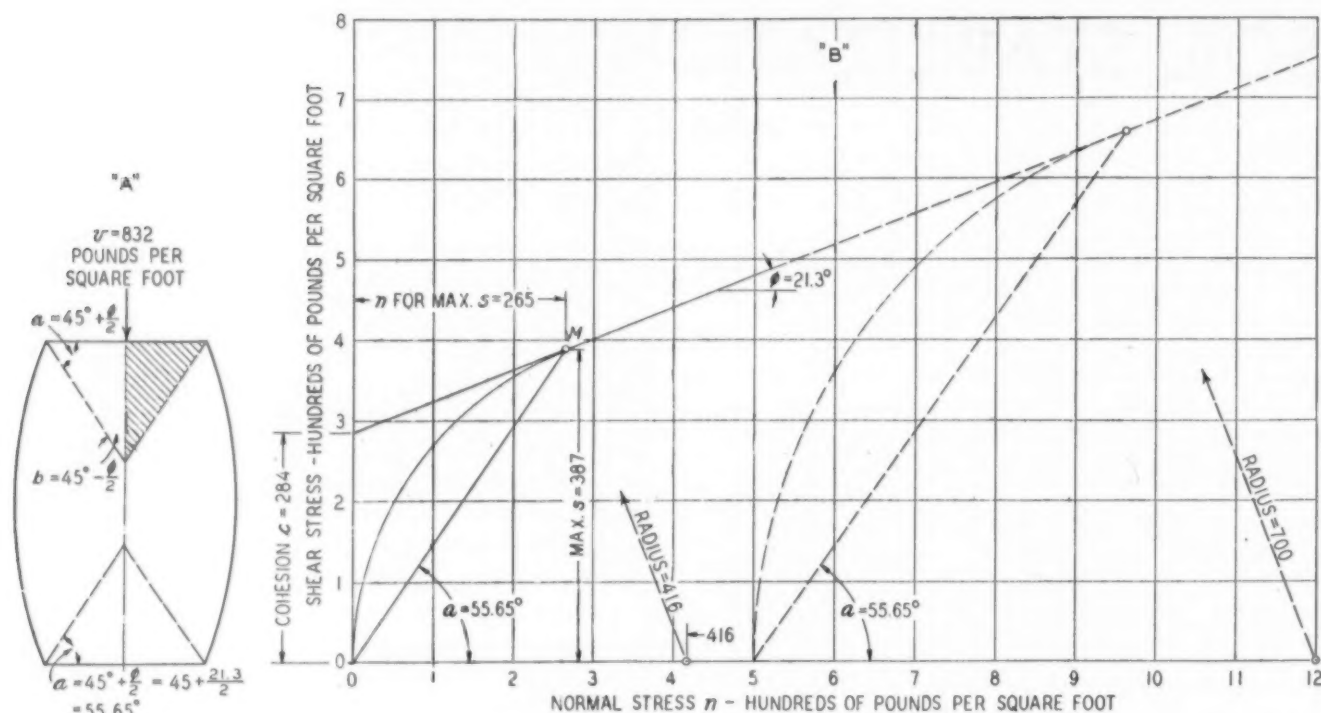


Fig. 2.—Graphical Representation of Stresses in Cylinder at Failure.

To distinguish between such knowledge of deformations as well as shear resistances, is required.

Failure of a vertically loaded cylinder is another type of test, and there is a growing feeling that such type of test has a number of advantages over the direct shear test for disclosing the cohesion,  $c$ , and the angle of internal friction,  $\phi$ , on which the stability of soil depends.

In this case it may be considered that cones formed at each end of the cylinder as shown in Fig. 2-A, move closer together as vertical deformation of the cylinder proceeds, and cause the soil material to first bulge and ultimately fail by having the sides of the cylinder split off. Theoretically the cylinder might fail along any planes which are between the cones, and parallel to the cone surfaces.

The angle  $a$  made by surfaces of the cone with the horizontal equals, according to theory,  $45^\circ + \frac{\phi}{2}$ ;  $\phi$  be-

ing the angle of internal friction along the surfaces of the cones at the instant the cylinder fails.

If it were possible to determine the angle  $a$  accurately by inspection of the ruptured sample, and if  $\phi$  equaled 21.3 degrees and  $c$ , 284 pounds per square foot as in Fig. 1,  $a$  should equal 55.65 degrees and according to the theoretical relation,  $v = 2c \tan a$ , the ultimate vertical pressure  $v$  should equal 832 pounds per square foot.

Such data can be analyzed by means of Mohr's circle of stress as follows:

With a center at a distance  $\frac{v}{2} = 416$  pounds per square foot, from the origin, an arc of a circle with radius  $\frac{v}{2}$ , is constructed as shown in Fig. 2-B (full

lines) and a line is drawn through the origin  $O$  at the angle  $a = 55.65$  degrees with the horizontal, until it intersects the arc at some point  $M$ .

TABLE I—ASSUMED VALUES OF  $a$  FOR DIFFERENT VERTICAL PRESSURES—FULL LINE FIGURE 3.

Vertical Deformation Per Cent of Ultimate	Vertical Pressure, $v$ Pounds Per Square Foot	Angle $a$ Degrees
4.6	290	49.65
9.2	396	51.0
24.6	558	52.9
50.7	690	54.3

According to Mohr's graphical procedure, the vertical projection of  $OM$  then gives the shear stress ( $s = 387$  pounds per square foot), and the horizontal projection of  $OM$  gives the normal stress ( $n = 265$  pounds per square foot) along the surfaces of the cones at the instant the cylinder failed.

A straight line drawn tangent to the arc at the intersection point  $M$  is the relation of  $s$  to  $n$ , and, as shown, gives the values of  $\phi = 21.3$  degrees and  $c = 284$  pounds per square foot, which were assumed.

If the stress-strain relation of the cylinder were such as shown by the full line, Fig. 3, and if by some means it were found that the angles  $a$  less than maximum  $a$ , for the  $v$ 's at percents of the maximum indicated by the circles, Fig. 3, were such as shown in Table 1, it would be possible to construct a series of diagrams in a manner similar to that shown by the solid lines in Fig. 4. These would disclose  $c'$  and  $\phi'$  values. And from such, the shear constant-deformation diagram could be constructed similar to that in Fig. 1, but with different deformation scale.

Unfortunately, however, the angle of fracture is not always defined clearly and angles less than maximum  $a$ , not at all by the tested sample. Therefore it is necessary to have at least another set of Mohr's circles and draw common tangents to corresponding circles in each set in order to determine the  $s$ - $n$  relations.

The desired supplementary data are obtained by testing cylinders of the soil at predetermined amounts of lateral restraint, and this may be done in apparatus which has the essential features shown by Fig. 5,

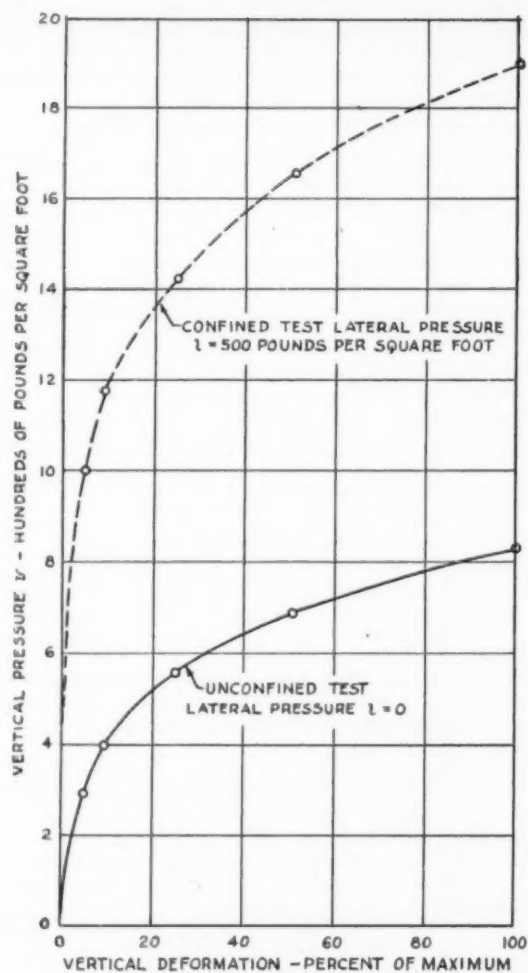


Fig. 3.—Stress-Strain Relation for Cylinder Test.

The cylinder encased in a thin rubber membrane between two porous stones, Fig. 5, is placed in a chamber filled with liquid connected to a manometer which can be adjusted to provide any desired lateral pressure. The developed vertical pressures are read from a second

manometer connected with a bellows on which the cylinder rests during test.

If from such test, with the lateral pressure,  $l$ , kept constant at 500 pounds per square foot, it was found that  $v$  at failure of the cylinder was 1,900 pounds per square foot, the corresponding stress circle is constructed

with a radius of  $\frac{1900 - 500}{2}$  and a center at  $\frac{1900 + 500}{2}$

distance from the origin. This is shown by the broken lines, Fig. 2.

In the same manner any number of circles representing stress produced by the values of  $v$ , broken line curve Fig. 3, may be drawn. In all cases their radii equal  $\frac{v - l}{2}$  and their centers are  $\frac{v + l}{2}$  distance from the

origin; see broken lines, Fig. 4.

By means of the apparatus shown in Fig. 5, an almost completely constrained compression test may be performed also. In this case the pressure gage, instead of the adjustable manometer would be used to determine the pressures in the chamber. If it were possible to completely prevent horizontal deformation of the sample, and if the voids were completely filled with water, there could be, excluding the deformation of the water itself, no vertical deformation of the sample either. In such case the relation  $l/v$  which has commonly been designated by the letter  $K$  depends on the elasticity of the soil and is not related to shear strength of the sample and therefore materials differing widely in strength may have  $K$ 's of the same value. Professor D. P. Krynie (6) and F. L. Plummer (7) and others (8) have called attention to this pertinent fact. Professor Krynie states: "The value of  $K$  in monotonously isotropic elastic bodies (confined water, some metals, etc.) is equal to one." Mr. Plummer states that "soil pressure at rest" depends not on cohesion and internal friction but solely on the elastic properties of the backfill."

While Mohr's circles could be constructed from the data which furnish the  $K$  values, it can be seen they would have no significance with respect to  $c$  and  $\phi$  values.

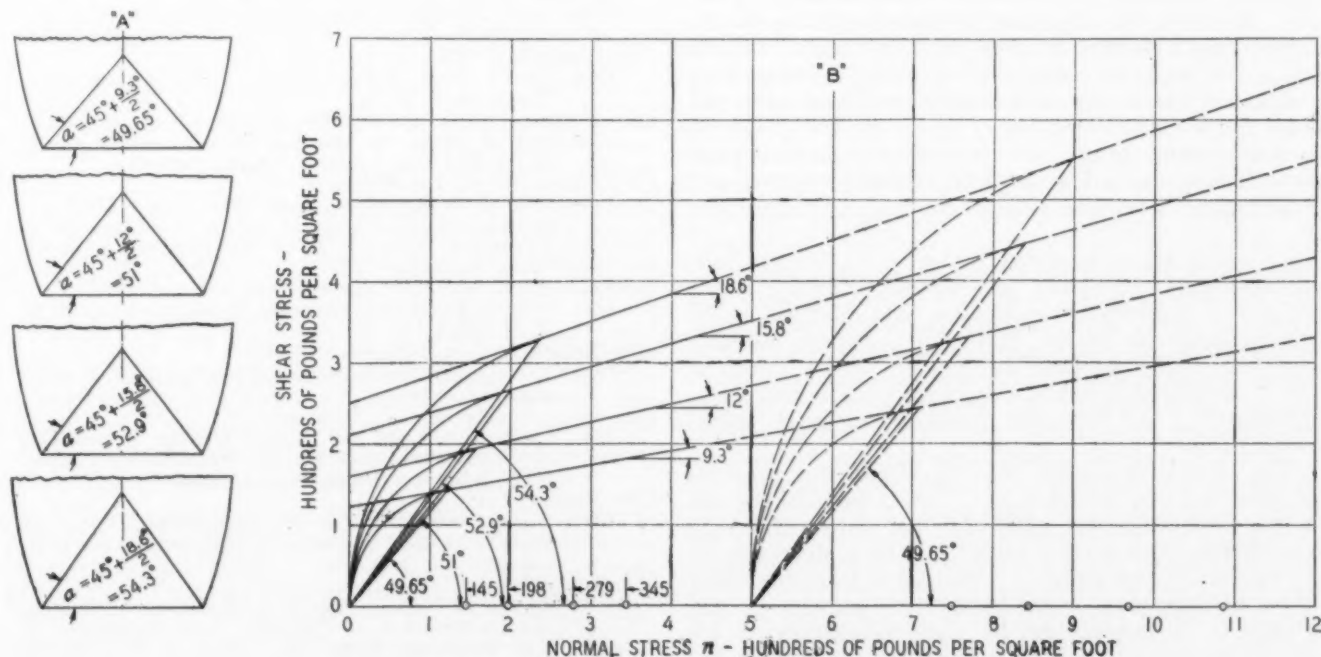


Fig. 4.—Graphical Representation of Stresses in Cylinder Before Failure.

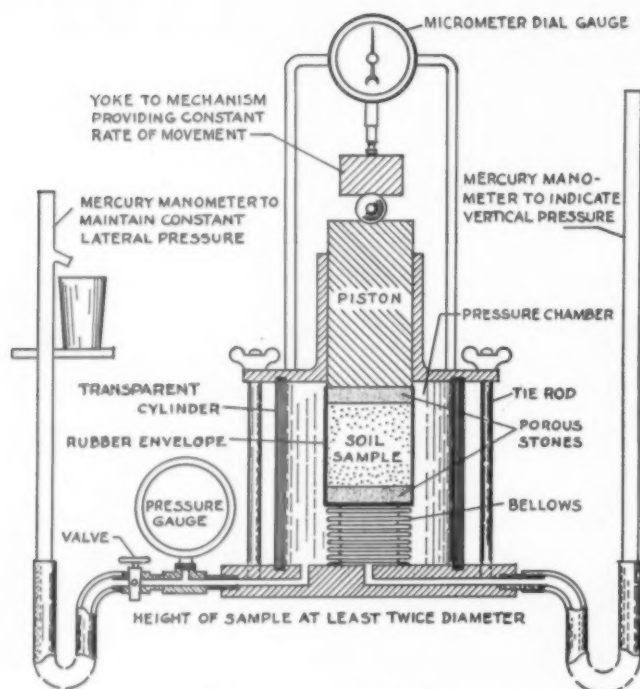


Fig. 5.—Schematic Diagram of Confined and Constrained Compression Test.

The "soil pressure at rest" is similar to what has long been called "equivalent fluid pressure" which may be defined as the pressure produced by an hypothetical fluid, equal in effect to the pressure exerted laterally by vertically loaded soil. For no deformation, the latter would become the same as "soil pressure at rest."

The idea of determining the ratio of lateral pressures to the vertical likewise is not new. J. A. Jamieson, in 1903, utilized manometers to determine both lateral and vertical pressures in a series of experiments made with model bins (9). A test to disclose this information was described also by Goodrich in 1904 (10); and a modification to the consolidation test for making similar determinations was described by Hogentogler and Willis to the Highway Research Board in 1932 (11). A considerably improved stabilometer, which utilizes a pressure chamber, was described to the Board by F. N. Hveem and Thomas Stanton in 1934 (12). Others, which provided for additional feature of maintaining a constant lateral pressure during test, have been devised by W. S. Housel (13), E. C. Seibert (14) and A. Casagrande (15). To regulate the lateral pressure, Housel utilized a weighted hydraulic piston, and Seibert and Casagrande an auxiliary tank of compressed air.

An enormous stabilometer designed for several hundreds of tons per square foot vertical pressure, is the key test of research on bituminous road mixtures at the great laboratories of the Shell Oil Company, Amsterdam (16). The essential features of the one shown in Fig. 5 are based on extensive experience in the determination of  $c$  and  $\phi$  by this means in the Delft laboratories (17).

The sample assembly separate from the pressure cylinder has two advantages. First, it permits the use of the thinnest rubber obtainable and thus reduces to a minimum experimental errors due to compression of the rubber. Secondly, if it is desired to learn the effect of water absorption on the volume and stability of soil, a number of samples can be made up, immersed for desired periods of time, have their volume changes observed and then their stabilities determined, Porous

stones provide for the elimination of capillary pressure effects during test.

By use of rubber containers having different amounts of restraint and accurate calibration, the confined compressive test alone, without the aid of the pressure chamber, will possibly provide all the data required for analyses of shear resistance by means of Mohr's circles.

A transparent cylinder, if used, permits view of the sample during test. The detachable top of the pressure cylinder facilitates removal of the sample for examination after test. Heights of the cylinder at least twice as great as its diameter is to prevent experimental errors due to and interference in tests on soils which have large angles of internal friction.

Provision for both increment and constant rate of deformation types of loading seems desirable. For controlling the lateral pressure the manometer shown in Fig. 5, the weighted hydraulic piston or a compressed air reservoir may be used.

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# ILLINOIS ROAD BUILDERS' ASSOCIATION MEETING REVIEWED

THE Illinois Road Builders' Fall Meeting held in Chicago on November 30th, surprised even the friends of the association by the scale of its success.

The keynote was opposition to diversion of highway funds to other uses, and it is to be hoped that through this and corresponding efforts elsewhere, this universally admitted injustice will be stopped in the near future.

The meeting began with a business session in the forenoon, followed by luncheon and an address by Charles M. Upham, Engineer-Director American Road Builders Association, of which the Illinois Association is an affiliate.

Mr. Upham gave a fascinating illustrated description of the German highway system which he visited last summer. His comments were especially interesting in their comparisons with American practice and developments. Regarding practice, he says that in equipment and methods, the Germans are about where we were 10 or 15 years ago, although they believe themselves to be the leaders. Their equipment is on the average at least twice as heavy as ours, and daily progress on construction very much slower. Some of the views showed industrial railway cars hauling concrete batches long distances to placement.

Regarding the development of a highway system, however, Mr. Upham admits that the Germans are far ahead of us. Their main routes have no grade crossings, and can be entered or left only at fairly widely separated points, where special accelerating and decelerating lanes are provided. Most of these roads have two 25-ft. pavements separated by about 12 ft. of ground, often planted out to grain.

In making their grade separations, the Germans have taken maximum advantage of every natural material and topographical feature, with the result that their structures are all different and interesting.

In general there is no speed limit on these routes, and it seems that the average rate of travel is about 65 mi. per hr. They are almost entirely free from accidents.

In drawing lessons for this country, Mr. Upham contended that we should provide greatly increased widths of right-of-way on our national highways, probably with provisions for excess condemnation such as has been so frequently recommended by city planners.

Following Mr. Upham's address, Ernst Lieberman, Chief Highway Engineer of Illinois, spoke briefly, emphasizing the importance of cooperation between contractors and highway officials, and pointing out to the former that the future of our road construction programs must depend largely on their promotional efforts.

Following the luncheon meeting came a series of papers and addresses primarily on points of fundamental interest to contractors. The first by Alan N. Buck, Secretary-Treasurer, Illinois Association of County Superintendents of Highways, related to the possibilities provided for in the refund to counties under section 15-D of the Road and Bridge Act. After outlining the history

and major provisions of the act, the speaker stated that at the time the last appropriation went into effect on July 1, 1937, there was a total of \$16,055,301.88 due all counties, of which there are 63 participating in the refund. Everyone interested in highway progress should use his efforts to convince the legislature that these refunds should be paid as fast as possible, still keeping in mind the general finances of the state. Mr. Buck was emphatic in his preference for contract over day labor work.

William C. Slee, Assistant Engineer-Director, American Road Builders Association spoke on the subject, "Negotiations for Using Contract System in Connection with WPA Projects." Mr. Slee, while admitting plenty of ground for criticism of WPA, felt that this agency has a very important and proper place in present day affairs. He outlined important committee conferences between the American Road Builders Association and the WPA, which he felt were leading in the right direction. Some of the difficulties connected with the employment of WPA labor on contract work are being smoothed out and other conditions improved. Mr. Slee feels very keenly that one of the main things to be accomplished is to sell the sponsor the idea that he can get more for his money through contract work than by day labor. This, he said, is primarily a job for local bodies.

Mr. O'Brien, in response to a query regarding Pennsylvania, from which state it had been reported that a satisfactory form of agreement between WPA, the sponsor, and the contractor, had been worked out and was now in effect, explained that the plan had not been put into use as expected, but that it was still hoped that a satisfactory working basis would be obtained. The original negotiations between the State Highway Department and WPA broke down over a question of transportation for the men, the WPA asking that the department carry them to and from their work, which request the department thought entirely unreasonable. It then proceeded to go ahead without WPA assistance.

Walter Hagemeyer, Assistant Highway Engineer in Charge of Permits, Department of Public Works and Buildings, State of Illinois, gave an outline of the policy governing overloads on highways. He explained that, whereas an occasional overload which does not strain structures beyond elastic limit could do no harm, the frequent application of excessive loads would ultimately lead to permanent damage. It is not practical, he said, to set up general provisions for overloads, and each case must therefore be treated independently. In general it has been easier to determine what should be allowed on a given piece of pavement than on a given bridge. While the highway department wants to do all possible to accommodate the movement of heavy equipment, it is obvious considering the nature of the case and the necessity for individual study, that permits cannot be issued by telephone and telegraph as is frequently requested. Therefore it becomes important that anyone wishing such

a permit get his application in in time for the necessary study and return of the document. Contractors are urged to file a record of their large units with the department in order that their applications may receive the speedier action when wanted.

*C. H. Hathaway*, Engineer of Construction, Division of Highways, in speaking on the subject, "Developments in Construction and Highways in Illinois," dealt pleasantly and informally with the broader phases, outlining past accomplishments and shortcomings, expenditures made, funds now available and to be expected in the near future, and dwelling heavily on the question of how we shall get money for new work after 1940. Bond interest, maintenance and replacement, policing, general administration and other items will absorb so large a part of the apparently large annual highway income, that an astonishingly small amount will be left for new construction unless means are found to augment what is now arranged. Modernization of widths, alignments and other features are important over many major routes, in addition to which there is the obviously necessary replacement of wornout surfaces. He stressed the fine understanding which is now common between engineers and contractors, in contrast with the conflicts characteristic of earlier years.

Mr. Hathaway emphasized the importance of a good secondary system, and pointed out that in some counties of limited resources, financing by the state or other agencies would be indispensable if a good secondary system was to be acquired.

To the contractor he was very explicit in saying that a view of two or three years ahead is inadequate, and that if he is to be successful in the long run, he probably should look at least ten years into the future, not merely with the idea of adjusting his equipment and organization to fit expectations, but with the purpose of promoting and assisting in the development of a sound highway program. He also stressed the importance of avoiding reductions in automobile licenses and gasoline taxes. In concluding, he reiterated the friendliness of one Department toward the contractors, and that a contractor's call is always welcome.

*Robert H. Ford*, Chief Engineer, Chicago, Rock Island and Pacific R. R. Co., began with a discussion of grade separations and ended with the much broader subject of honesty and cooperation in the construction industry. Especially did he plead for elimination of unnecessary red tape from governmental contracts of all sorts. The majority of contractors, he feels, are honest if given a chance, but are frequently put in an almost impossible position by unreasonable specifications and the unreasonable attitude of engineers and inspectors. With the gyp contractor and the incompetent he has, of course, no patience. Corrupt politics in the construction industry, he attacked bitterly, as he did also the "insurance racket."

To Thomas H. MacDonald, Chief, U. S. Bureau of Public Roads, and his staff, Mr. Ford paid the highest compliment for their administrative and technical abilities and pointed out that they are proceeding with simplifications and improved practices as fast as the conditions under which they work permit. Legislative action will be necessary on many points before the desired end can be attained.

He also made mention of the "Theory of Benefits," under which, insofar as possible, the cost of improvements are charged to those in whose interests they are incurred.

*L. Philbrook*, Assistant Bridge Engineer, Div. of Highways, presented a paper entitled, "Why Permits for Overloads on Highway Bridges?" This paper supplemented in a measure the previous one by Mr. Hagemeyer, and clearly showed the difficulties with which engineers must contend in dealing with the overload problem. The speaker treated at some length the problems of stresses resulting from varying axle and wheel spacings and other variable factors.

Professor *C. C. Wiley*, University of Illinois, discussed briefly "The Big E Safety Factors in Engineering and Design of Highways." The three E's he listed as education, enforcement and engineering, the last named being dominant. Every project, he pointed out, may be divided into six steps—conception, planning, design, construction, maintenance and operation.

Curvature and superelevation, he discussed very pertinently, laying stress on the importance of introducing spiral, or transition curves if real safety is to be attained. Where transition is omitted, the superelevation extending out along the tangent draws a car to the lower side, thereby greatly increasing risk of accident.

He criticized the retaining of the old emphasis on the balance of cut and fill in making locations, pointing out that in some cases, such balance is attained at the expense of a safe alignment, grade and sight distances.

Traffic signals, he said, may be either helps or hindrances—safety devices or hazards—and explained these matters briefly.

**Banquet Addresses**—Following the afternoon meeting came the banquet in the grand ballroom of the Palmer House, the speakers of the evening being F. Lynden Smith, Director of Public Works and Buildings, State of Illinois; Honorable Murray D. Van Wagoner, Highway Commissioner of the State of Michigan and President of the American Road Builders Association; Paul G. Hoffman, President of the Studebaker Corporation and Automotive and Safety Foundation; and D. D. Fennell, President of the National Safety Council.

*Mr. Smith* after complimenting the road builders on the character of their work, their sincerity and cooperation reviewed briefly the development of safety provisions, the necessities for reconstruction and improvement of highways, the problem of the contractor, and the development of highways thoroughly in the interest of all highway users.

*Mr. Van Wagoner's* address dealt almost entirely with the subject of constitutional amendments to prevent diversion of gasoline taxes and other highway funds, and included an interesting and very clear outline of the manner in which the Michigan amendment preventing all diversion was secured.

The speaker took obvious pride in the fact that in the recent election in Michigan, every county gave a majority in favor of the amendment.

*Mr. Hoffman* spoke briefly but magnetically in introducing his friend, *Mr. Fennell*, whose subject, entitled "Net Results," provided a fitting summary and conclusion to what had been previously said regarding "honesty," "cooperation," "safety" and other subjects.

To the officers and directors of the Illinois Road Builders Association, as well as to the many committee members and others whose work contributed to the success of the meeting, a vote of thanks is due by both members and guests who attended. It is interesting to note that some 800 road builders and their friends sat down to the banquet.

# BRITISH RESEARCH ON ROADS

**M**ANY topics of interest both to road engineers and users are discussed in the annual report\* of the British Road Research Board for the year ended March 31 issued late in October by the Department of Scientific and Industrial Research, 16 Old Queen St., Westminster, S. W. 1, London, England. The work described in the report is carried out at the Road Research Laboratory, Harmondsworth, Middlesex, England, and its object is the accumulation of the scientific knowledge essential to the economical and efficient construction and maintenance of our roads.

## Impact Tests

The measurement of impact forces between a vehicle and the road has led to important results during the year. It now appears possible, the report states, even in the complicated case of a 6-wheeled truck, to predict, from a knowledge of surface irregularities of a road and the vehicle characteristics, what forces will be imposed on a road. Impact measurements have been checked by high speed cine pictures of wheel movements and type distortions during the passage of vehicles over an irregular surface. Records were made on a private car traveling over an obstacle at 22.5 and 50 miles per hour and of a lorry at 15 and 40 miles an hour, the pictures being taken at a rate of 1,000 to 2,000 per second.

In the ultra high-speed camera the exposure given to each picture is of the order of 1/6000 second which demands a lighting intensity on the object to be photographed much greater even than is provided by bright sunlight. This lighting was provided by photographic flash bulbs arranged in a row a few feet from the path of the wheel. These bulbs were exploded by a succession of electric contacts placed on the road and operated by one of the front wheels of the test vehicle.

## Skidding Tests

Skidding tests are to be made on road surfaces at speeds up to 75 miles per hour by an apparatus towed behind a high speed car. The technique of road texture printing, in which a portion of the road surface is inked and a kind of finger print taken from it, has been improved. In its present form, this method has shown itself very useful in recording surface condition and surface changes.

The report refers to a method of improving the skidding resistance of those few concrete surfaces, which through faulty design or workmanship are undesirably smooth. This consists in treating the surface with acid. Tests have shown that marked improvement is thus obtained. The cost of this method is likely to be considerably less than the cost of resurfacing.

The report states that investigations on the pressure exerted by pneumatic tires on road surfaces have also developed in a way which has led to a better understanding of skidding phenomena. It has been found that local pressures on small projections, such as the individual stones in a surface dressing, may amount to many hundreds of pounds per square inch, and that the intensity of pressure depends to a marked extent upon temperature. It has long been known that large

seasonal variations occur in the skidding characteristics of road surfaces, and it now seems probable that changes in the physical properties of tires may be responsible for a part of these variations. Work which is now in hand will make it possible to examine this hypothesis.

## Tests with Road Machines

The normal sequence of investigations at the Road Research Laboratory is small scale laboratory work, tests with road machines, and, finally, full scale road tests. The road machines enable actual road conditions to be reproduced at the Road Research Laboratory and sections of roads constructed in various ways to be subjected to accelerated traffic tests. In the largest of the three machines in use a full-sized truck is driven electrically at speeds up to 40 miles an hour round a circular track 110 ft. in diameter. Another small machine is now under construction in which conditions of temperature and moisture met with on roads can be reproduced artificially. Weather statistics are being collected from different parts of the country so that suitable cycles of sun, rain and frost can be worked out.

The value of road machine tests depends entirely, the report points out, on the degree to which the relation between such tests and tests on the roads themselves is known. The road machines are now fully occupied in an attempt to establish this relationship. In comparing road machine tests of various road surfacings with tests on the open road a knowledge of traffic conditions is required. Special apparatus has been devised which automatically counts throughout the 24 hours the vehicles passing in both directions along a road. This apparatus has been installed at the Colnbrook by-pass outside the Road Research Laboratory. The traffic in passing over rubber traffic pads, inserted in the road, of the type usually used for actuating traffic lights, closes relays, which in turn operate a number of electric counters. The pads are adjusted so as not to count pedal cycles. It is not only necessary to know the volume of the traffic, but how it is distributed across the width of the road. This is being determined by a "camera obscura" placed in a hut alongside the road. In this hut, observers see a view of the road optically projected on to a white disc on which lines are drawn parallel to the curb. Thus without making any lines on the road itself, which might affect the normal flow of traffic, the sections of the road used by various types of traffic can be observed. What is called a wet road clock, depending on the changes of electrical resistance between metal strips laid in the road, records the length of time that a road is wet or dry.

## Road Foundations

An increasing amount of attention has been paid during the year to the study of road foundations. The whole position of research on earth works and foundations in relation to roads has been reviewed and emphasis has been given to certain of the problems which formerly received little attention. These are concerned with embankment construction, the behavior of soils under concrete slabs and soil surveys prior to construction. In the course of the construction it is often important to know the extent of the consolidation or

\*The report can be obtained from H. M. Stationery Office, London, England, for 3s.

"compaction" of the soil. This is measured by what is called a "plasticity needle" which is a blunt plunger with which the compaction of the soil is found by determining the force necessary to drive it into the soil at a given rate. When excavating for a road it is generally desired to balance the volume of the excavated material against the volume of that used for filling. The engineer often desires accurate information on the "bulking" of a soil, that is the change in volume when it is excavated, deposited and compacted as filling. Reliable figures are sometimes difficult to obtain, and the Road Research Laboratory is endeavoring to collect such data from constructional works.

### Bitumen and Tar

For measuring the temperature inside bituminous road carpets during laying and rolling an electrical thermometer is used with which a thermojunction is formed at the point of a hypodermic needle. This instrument is similar to that used for measuring temperatures inside tires.

Among laboratory investigations described in the report now brought to the point of full scale testing is work on bituminous surfacing mixtures. The simple forms of test devised for bituminous materials have been applied to the determination of the most suitable binder contents for different types of aggregate, filler and binder. The measurement of the bulk density of fillers when suspended in benzene has shown that a definite relation exists between this property and the optimum proportion of filler to tar. The addition of small percentages of chlorinated rubber to tar has been shown to be accompanied by certain improvements in properties. Chlorinated rubber is rubber which has been treated with chlorine either in the form of a gas or a liquid. In general it has been found that the addition of chlorinated rubber to tar extends the temperature range over which the material remains plastic. In other words, it tends to prevent it becoming brittle in winter and soft in summer.

In all cases, however, the true significance of these results can only be fully appreciated when they are tested out under practical conditions on the road. Arrangements for such trials are in hand. To some extent, they are already in progress in an experiment on the Colnbrook by-pass, in which forty-four sections of differing compositions have been laid on the road, under carefully controlled conditions. Observation is being made of as many factors as possible contributing to the wear and deterioration of the surfacings, and the carpets themselves are being subjected to the closest scrutiny throughout their useful life.

### 1937-'38 ROAD IMPROVEMENT EXCEEDS 10-YEAR AVERAGE

Over 15,000 miles of highway were improved during the fiscal year ended June 30 last in the program administered by the U. S. Bureau of Public Roads, according to the annual report of the bureau. The bureau also supervised the elimination of 711 grade crossings, reconstruction of 144 obsolete grade-crossing structures, and protection of 744 crossings by signs and signals. Both the amount of work done per mile of improvement, and the total mileage improved, have considerably exceeded the average rates over the past 10 years.

The greater portion of the work was done in cooperation with state highway departments and in this way 12,129 miles of highway was improved. This work

included 9,333 miles of rural portions of the Federal-aid highway system, 559 miles on municipal portions of the Federal-aid system, 201 miles of secondary roads in municipalities, and 2,036 miles of rural secondary roads.

Classified according to type of construction, the year's work in cooperation with the states consisted of 1,506 miles of graded and drained road; 4,998 miles of treated and untreated sand clay, gravel, and macadam; 1,989 miles of low-cost bituminous mix; 213 miles of bituminous macadam; 419 miles of bituminous concrete; 2,870 miles of portland cement concrete; and 134 miles of bridges, grade separations, and miscellaneous types.

Advancement during the year of the program of eliminating hazards to life at railroad grade crossings was an important contribution to highway safety. In addition to the protection of life and property, grade separations effect considerable savings in time and inconvenience to public travel on the highways, according to the report. More than half of the expenditures during the year for this class of work was in municipalities, reflecting the relatively greater danger and delays at city and suburban crossings.

The year saw the near completion of the emergency program of road construction, and was marked by the initiation of Federal aid for secondary and farm-to-market road construction and the extension of outright Federal grants for highway-railroad grade crossing elimination as parts of the regular Federal highway program.

During the year the bureau supervised road construction in National parks, National forests, reconstruction of flood damaged roads, and roads financed with funds allotted by the Public Works Administration and the Works Progress Administration. Work of this class aggregated 3,215 miles.

### SOUTHWEST ROAD SHOW AND SCHOOL

One of the highlights of the Twelfth Annual Southwest Road Show and School which will be held Febr. 21 to 24, Wichita, Kan., will be the Engineers' and Road Builders' Banquet sponsored by the Engineers' Club and Road Builders to be held Wednesday evening, Febr. 22.

A partial list of guests will include state and county engineers, county road building officials, and road building contractors.

A program is being arranged and a speaker of outstanding merit whose name will be announced later will be the keynote of the evening.

Fred G. Wieland, General Manager of the Road Show, anticipates a large attendance on account of the unusual interest taken at this early date.

### SEMI-TRAILER TRUCKS ARE 14% OF TRAFFIC ON FOUR INDIANA ROADS

The tractor semi-trailer unit makes up approximately 14 percent of all traffic on four of Indiana's major trunk highways, according to a report of the Indiana Bureau of Highway Planning.

The survey made on Roads 20, 6 and 30 which cross northern Indiana, and on Roads 52 and 41 between Indianapolis and the Indiana-Illinois state line revealed that this type of freight-hauling unit made up more than half of the commercial vehicles operating on the four routes. More than half of these trucks were from outside Indiana, except on the route between Indianapolis and Chicago, where Indiana vehicles predominated.

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## SELLING HIGHWAYS

Public relations is an important phase of the highway administrator's work. By keeping the public informed on the activities and fiscal condition of the department, he is insuring a continued highway program. Following is a discussion on some of the activities of the Montana State Highway Department taken from their mimeographed circulator called "The Center Line."

### ROAD CONDITION REPORTS

*By Mary Dimich*

Among the foremost factors in promoting traffic over Montana's highways are the weekly and daily road condition reports compiled through the cooperation of the maintenance forces in the field, the division offices, and the maintenance department in Helena. The traveling public gets authentic information on snow blockades, washouts, floods, construction operations, load limit restrictions in effect, and the condition of the highways for winter driving.

Road reports were first issued weekly in May, 1928, the highway department cooperating with the Montana Automobile Association in the connection referred to. This information was distributed through the press every year during the summer months.

In 1933 the highway office in Helena began writing up a consolidated weekly report for the use of the division engineers in answering inquiries from motorists. The changing conditions at that time were wired to Helena every Friday night by code. During the tourist season the Montana Automobile Association again distributed road information. The highway department continued this phase of work that fall, placing the Associated Press, the United Press, and several travel bureaus on the mailing list.

The demand for authentic reports on the condition of the highways in Montana increased and the data was run off on the ditto machine after the first of January, 1935, and mimeographed when the tourist season began. A steadily increasing mailing list necessitated the purchase of an addressograph machine in November as seventy-five reports were sent out weekly to all parts of the United States and carried in the Associated Press dispatches to the newspapers in the state.

Early spring break-up conditions caused restrictions to be placed on the oiled highways again, which additional information lengthened the report. A more detailed, two page bulletin was issued after July 3, 1936, showing the length of the routes on the state highway system and their general condition, including construction work and detours. At the beginning of the next tourist season the type of surface, whether oiled, graveled, or unsurfaced, length of construction and detours, and its condition was shown on the reports, giving more complete information on the highways in Montana.

The purchase of an electric mimeograph machine lightened the task of getting out the road report each Saturday morning as approximately 800 copies were distributed throughout the United States during the tourist season.

The division offices send in weekly comprehensive data on road conditions which are supplemented by telegraphic or telephoned reports whenever washouts, slides, blockades, or hazards exist on the highways. A consolidated bulletin is compiled Saturday morning by the Maintenance Department in Helena and sent to every state in the Union, province of Canada, and also Hawaii.

Cooperation is now extended the division offices by the U. S. Bureau of Public Roads whose field men report on the condition of the BPR sections.

To promote tourist traffic through Montana, the Montana Automobile Association has distributed weekly between 500 and 600 copies of the road report during the last two summer seasons.

104 new names have been added to the maintenance department mailing list so far this year. Montana exchanges road bulletins with the neighboring states, North and South Dakota, Wyoming, Idaho, and five other highway departments. All members of the Highway Patrol get a copy of the weekly report which enables them to answer inquiries as to road conditions.

At the Port of Entry stations authentic information on routings, and the condition of the highways is available to tourists entering the state as the bulletins are mailed to the attendants of the nine courtesy stations. Field reports sent in by the division engineers and the consolidated report aid, Mr. R. H. Fletcher, Traffic Engineer, in answering inquiries from people contemplating trips through Montana. The Montana Automobile Association office in Helena and the other widely scattered travel agencies in the United States do their part through the use of the weekly road reports in promoting traffic through the state, advising as to the most feasible routings, scenic attractions, etc.

Road condition bulletins are dispatched over Associated Press wires to the seventeen daily publications, including nine Sunday papers. On Saturday the consolidated information is sent out. This is supplemented daily by such reports on dangerous situations on the highways as may be warranted. The same facilities are offered the public through the United Press, and the division offices also advise the press of road hazards.

In Helena, Butte, and Great Falls, broadcasts are made several times daily. The local radio stations at Billings, Wolf Point, Missoula, and Kalispell send out reports during emergencies, such as snow blockades, floods, washouts, or adverse weather conditions.

Telephone inquiries have become more frequent in past years as tourists and local motorists call upon the Highway office daily requesting road information. A record kept during a storm period last year showed an average of forty calls an hour at the maintenance department office asking for road condition reports. The users of Montana's highways are becoming more safety conscious and rely upon authentic guidance, especially during the winter months.

After being advised by the field maintenance forces, the division offices promptly transmit changing conditions on highways until the storms have abated or the situations remedied so as not to hinder travel at any time. This splendid cooperation enables the highway department to save motorists from inconvenience and to assist in reducing the automobile death toll in Montana. Also, it has increased winter traffic immensely.

▼  
YARNALL REELECTED PRESIDENT UNITED ENGINEERING TRUSTEES—D. Robert Yarnall, chief engineer of the Yarnall-Waring Company of Philadelphia, has been reelected president of United Engineering Trustees, of which the Engineering Foundation is the research organization. Other officers were named as follows: Henry A. Lardner of J. G. White Engineering Corporation, New York, first vice president; Albert Roberts, secretary of the Minerals Separation North America Corporation, New York, second vice president; H. R. Woodrow, vice president of the Consolidated Edison Company of New York, treasurer; J. P. H. Perry, vice president of the Turner Construction Company, New York, assistant treasurer.



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# INTERNATIONAL TRUCKS

# HANDICAPS AN ENGINEER HAS TO OVERCOME

By C. C. WILEY

*Professor of Civil Engineering,  
University of Illinois*

**W**HILE the problems of roadbuilding and of traffic handling are many and complicated, the engineer is intrinsically capable of solving them, but unfortunately he is hampered and retarded by numerous handicaps, many of which are out of his control.

First, there are the people. So directly and intimately is each citizen in contact with the highways that unconsciously he feels he knows all about them. People who would not attempt to tell the railroad engineer how to build, operate, or provide signals for a railroad, do not hesitate to dictate to the highway and traffic engineers where and how to build the roads, or where to install signs and signals, or otherwise regulate the use of the highways. The result is that the engineer spends a great deal of effort in trying to educate the people to their needs, and in preventing them from getting in the way of their own best interests.

**The Traffic Engineer Is Told**—A famous philosopher once said that popular opinion is normally wrong because it is merely the summation of the experiences of a number of individuals, none of whom is in a position to have a complete picture of the situation. Nowhere is this more true than in the traffic field. The average person will remember one inconvenience and forget a thousand favors. Thus it is by no means uncommon for people to insist that some traffic device is needed at some location merely because on a few occasions they have individually had difficulty there. And they will claim that the traffic engineer who has studied the situation from all angles under all conditions is crazy when he says that the device is not needed, or that something else will serve the greatest number for the greater part of the time.

Recently a group of anxious parents besought the authorities to install a half-breed signal at a school crossing, and were provoked when the authorities refused because a competent traffic engineer after careful study reported that the signal would be more of a hazard and less effective than the school-boy patrol already on duty at that location. This engineer had the disagreeable but none the less real duty of protecting the children from their parents rather than from the traffic.

**The Mugwump Defined**—Then comes politics, pronounced with that familiar nasty inflection, which subverts public interest to private gain or party policy. Politicians are many but statesmen are few.

Intrinsically the engineer is a mugwump. That political animal you know, who has his mug on one side of the fence and his wump on the other. But being thus sort of balanced, as it were, he is likely to do some balanced thinking, and the politician always has been afraid of the thinker. You all remember what the greatest roadbuilding politician of all time is credited with saying about the thinker. It begins "Let me have men about me that are fat" (today he probably would have said "fatheads") and ends, "he thinks too much. Such men are dangerous." I hazard the guess that Cassius

was the Chief Engineer of the Roman Highway Department and did not agree with Caesar's policies.

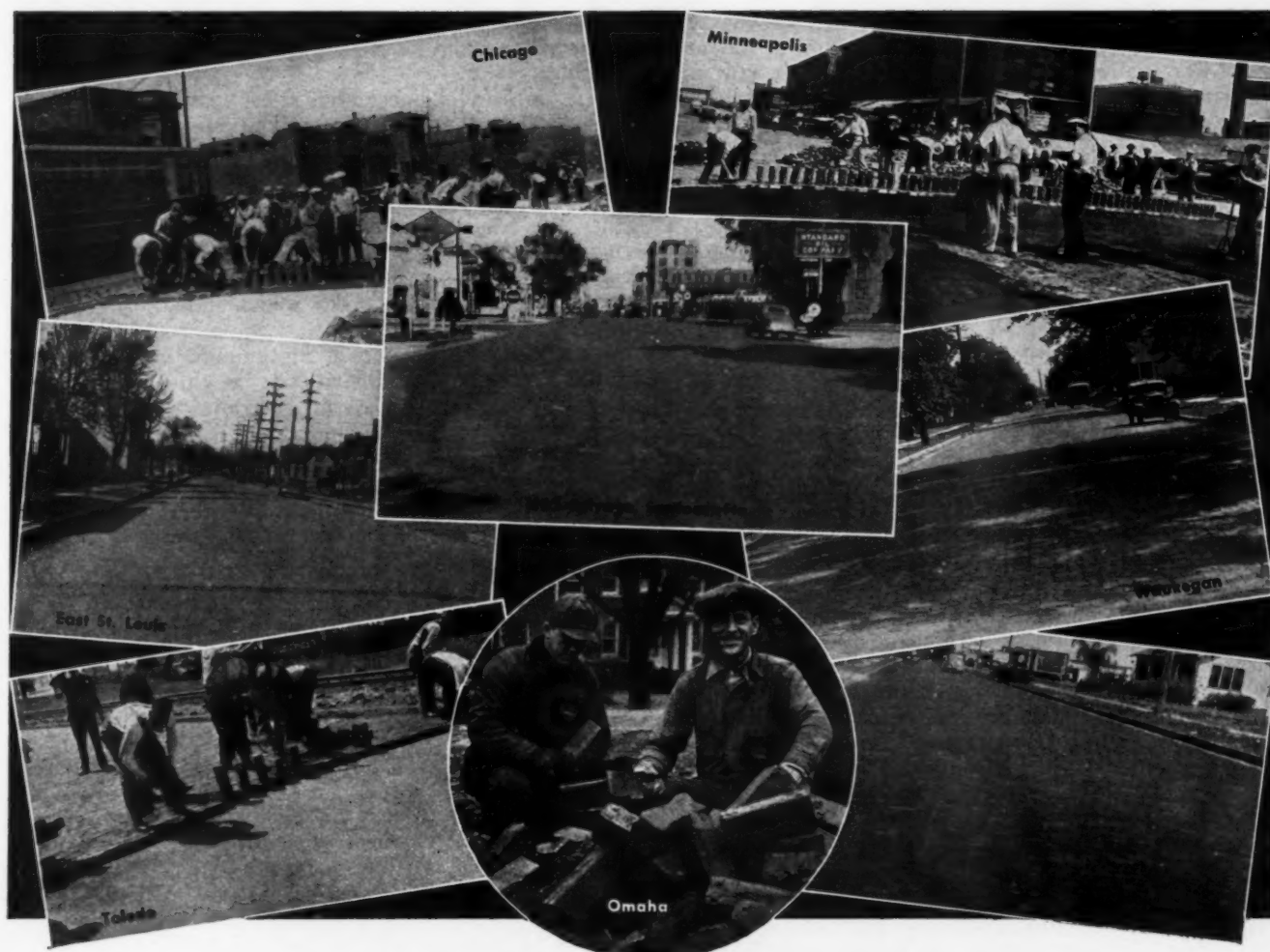
**The Financial Problem**—One of the most direct and embarrassing handicaps that faces the engineer is the eternal lack of adequate funds for the job. The American people will spend money like drunken sailors for new cars, but will squeeze a penny until Lincoln is black in the face when it comes to buying adequate roads on which to run them. The average owner thinks little of charging off \$100 or more a year in car depreciation, but just try to get that much out of him for adequate roads and efficient traffic supervision and hear him squawk. The average motor license fee and gas tax in Illinois is only about \$33 a year, yet the motorist in one breath yells that he is taxed too much and in the next clamors for more roads and greater safety on them. So far, however, he seems to prefer to spend enormous sums in insurance premiums, property damages, hospital bills and funeral expenses, not to mention the horror and sorrow of injuries and deaths rather than the comparatively smaller sums that would be needed to build and operate highways that would do away with much of these. Neither adequate highways nor safe highways will be attained until we the people are willing to pay the price for them.

But all of the handicaps to the engineer are not external. He has many foibles of his own that often get in his way. One of these is an excessive credulity which prevents him from applying adequate discount factors to advertisements or sales talk. As a result our roads are chock full of contraptions whose principal merit is the profit they yield the maker.

**The Inferiority Complex Handicap**—Another aspect of this credulity is the tendency to accept what others say about us and our profession and thus develop a sort of inferiority complex. Why do we permit the "highbrow" to say that the engineer is narrow and lacking in human interest? I say to you that engineering is the broadest and most human profession in existence for it covers all phases of human endeavor and is pledged to the service of mankind. The so-called scholar is normally more narrow and his work more devoid of human interest than the engineer.

But the engineer himself often does need humanizing. He is all too prone to take everything, including his job and his play, too seriously. He needs to loosen up and get all the joy out of life and thus make life more enjoyable for others.

It has been said that the engineer cannot talk. He can talk, and talk well, usually if he gets mad enough. It isn't that he can't talk; he just does not. To him many things are simple, and he thinks they are simple to others, but in reality they are not simple to others. If the engineer does not make them clear some amateur will try it and make a mess of it, which the engineer later has to straighten out. The engineer's job would often be easier if he would just talk at the right time.



# SALVAGE

*—for taxpayers, a "BONUS"; for labor, a "BREAK"*

Brick pavements have an exclusive advantage of a broad economic nature. After long service, the brick units have high salvage value.

Salvaging and relaying old brick on their new base is rarely ever an emergency\* matter from the traffic standpoint. And this flexibility as to time when the work may be done permits postponement from periods when labor is scarce to times when men need employment.

Thus, relaying does not compete with private employment in good times; it furnishes a backlog of needed hand-labor when labor must have employment.

\*The Reason: At any stage of service, brick resists damage from weather as well as traffic.

In recent years the Works Progress Administration has utilized this work with splendid results. Salvage of 40-year brick has often run over 75%. Engineer Fred T. Williams reports 116% salvage at Sanford, Fla., where "on edge" brick were turned flatwise in the new pavement. WPA forces turned out a good job which should equal the service the 36-year brick had already rendered.

New or relaid, brick has the longest life and lowest upkeep. Safe. Pleasant to ride on. And the big salvage is a "bonus" to taxpayers and a "break" for labor. National Paving Brick Association, National Press Bldg., Washington, D. C.

# BRICK

**LONGEST LIFE . . . LOWEST UPKEEP . . . GREATEST SALVAGE VALUE**

All of these boil up into the fact that the engineer needs to assert himself both personally and professionally. Personally it may be an individual job, but professionally it is a job for all, and one of the first steps is to see that his profession, like the other great professions, is protected from the incompetent by adequate registration laws.

**Making Simple Things Hard**—Engineers are often handicapped by a propensity to make something hard out of a thing that is really simple. This seems inherent in students but the engineer should get over it. A result of this tendency is to develop a fear of things and avoid them when we should use them. How else can we explain the antipathy of the highway engineer to the spiral? He knows it is desirable but does almost anything to avoid it because he thinks it is hard and therefore is afraid of it. Some of you may think I am exaggerating when I say that here at Illinois we expect our students in route surveying to be able to apply the spiral to other simple or compound curves with no other auxiliary than a set of trigonometric tables. Or you may think I am crazy when I say that all the information needed to apply the spiral to the highways of this state can be typewritten on one side of an ordinary  $8\frac{1}{2} \times 11$  sheet of paper. The spiral is hard because the majority of writers made it hard by starting at it the wrong way, and then littering the nomenclature up with a flock of Greek letters. They began by fixing the spiral length and then adjusting the curvature to it. The easy way is to choose the curvature and then chop off a piece of the right length, exactly analogous to the way you do with circular curves.

Many engineers are eligible for the Ancient Order of Formula Hounds or the Society for the Universal Use of Tables and Diagrams. A formula is merely shorthand for a complicated statement, while diagrams and tables are mere devices for reducing routine work. None of these should ever be substituted for thinking. We have too much handbook engineering as it is. The first and most important step in any problem is to "use your head." Formulas, tables, and diagrams are merely helpers.

**Confusing Standards with Limits**—Closely related to this is the desire for standards, and as a result we often overstandardize. Standardization was a big help in the period of mass production of highways during the last two decades, but it has given us many of the present problems of trying to fit traffic to the roads. One of the biggest difficulties with standardization is the tendency to confuse standards with limits. Thus I have heard it said that the standard radius for highway curves in Illinois is 1,000 ft. There never was such a standard and no one ever intended that there should be. The correct statement was that 1,000 ft. was the minimum limit for the radius. And yet we have all seen and possibly some of you are guilty of having made road plans with 1,000 ft. radii when there was nothing in God's green world but a flock of corn stalks to prevent radii of much greater and therefore more desirable length. Let me revert again to the spiral for an example. Professor Moyer out at Ames made some interesting and valuable experiments on skidding and, as a by-product, he evolved a formula for minimum spiral length. His writings clearly indicate that it is the minimum. And yet, unless I have interpreted the sheets recently received from Springfield incorrectly, and I hope I have, this state has adopted Moyer's formula for determining the *desired* length. A little study of the derivation of this formula, a little calculation involving lateral acceleration and a comparison with railroad prac-

tice shows that the *normal* highway spiral should be somewhere around twice as long as indicated by Moyer's formula.

The highway engineer seems very loath to learn from others. He has a sort of inferiority complex that makes him want to be self-contained and so goes on committing many blunders. For example, the railroad learned, years ago, that the degree of curve is superior to the radius when the transit is used for location but the highway engineer hangs on to the radius like grim death. The city engineer has learned many things about curbs, gutters, crowns, inlets, expansion joints, and a host of other things from which the highway engineer might greatly profit. There is no excuse for building country roads inside of cities and then wondering why they don't work. It is just another case of fitting traffic to the road instead of the road to the traffic.

**A Slave to Precedent**—We laugh at the lawyer as a slave to precedent, but the engineer is often as bad or worse because he has often permitted this to degenerate into habit. We keep on doing things just because we have always done them and are apparently too lazy to think out better ways. Have any of you committed the atrocity of putting notches in a concrete curb at private driveways? If so, why? This was perhaps permissible with some stone curbs because cut stone corners are very expensive but with concrete that can be molded, it is inexcusable. If you have done this go out and look at them and then figure out how the owner (or you) are going to pave this driveway so that it looks well and will not bruise the tires of a car turning in. Wouldn't it be a lot better to start the curve of a decent turnout. I once asked an engineer why he did not do this and he said it would cost too much. When asked how much more it would cost he said he did not know. In point of fact it costs exactly nothing as you can prove by a little figuring or call for bids.

Why do we face our road signs straight down the road? Because we have always done so and we struggle to be conventional. The application of some simple laws of optics would tell us how they can be set for greater visibility and freedom from glare at night at absolutely no additional cost. But force of habit makes us work harder, lose efficiency, and increase the cost.

Some of the older engineers that have come up through the rush and turmoil of our mass production period are having a hard time overcoming the habits formed during that period, and thus clearing their minds to new thought processes necessary to meet present conditions. It is hard for them to see that traffic considerations are, after all, the controlling features in modern road building, rather than balanced earthwork, cheap right of way, or mass production.

We engineers must constantly guard against losing sight of the purpose of our work in the maze of its details. Roads are built to serve traffic, not just for the fun of it, or to break construction records. Too often we let the tail wag the dog.

**The Traffic Engineer**—And now just a word about the baby of the family, the traffic engineer. He has a man-size job but he is only a youngster and needs development. To meet present needs engineers in other lines have been transferred to traffic work. Many of these are doing a magnificent job because they have the necessary makeup, habit of thought, and attitude. Some are failures because they have not had the necessary attributes, which are just as peculiar to this job as those peculiar to, say, the bridge engineer. But the future is calling for more men and we should look to developing them. The next generation of traffic

(Continued on page 61)

# WARREN COUNTY'S GAINS

*are Better Roads That Pay for Themselves*

What's your next move? Building a new road . . . realigning or maintaining old ones? Or maybe you feel the cost of special ditch-digging equipment has made better drainage prohibitive on your road system.

Then take a tip from Warren County, Iowa. They've found their equipment investment is no index to the cost of good roads. Since they took delivery on their LeTourneau Model "G" Carryall last February, it has met virtually every road building requirement. For instance: because the Carryall finishes as it handles all heavy cuts and fills, no rehandling was necessary in modernizing an old market road near Truro (shown). The same fractional-inch digging and spreading, maintained by accurate cable control, proved equally effective on bank sloping. The cutting blade, extending full

wheel width, permitted widening right up to the fence lines, next to banks, then *completed* the job by cutting wide-bottomed ditches along the sides. Yes, this Carryall is a perfect county Scraper . . . it was built with county savings in view.

. . . on your own peculiar road construction needs, we'll wager all your jobs, today and tomorrow, can be handled faster, better and cheaper at typical all 'round LeTourneau Carryall savings. In other words, what we offer you is this: *more miles of better roads for the same equipment dollar.* Your "Caterpillar" dealer is ready to back up every claim with a convincing demonstration . . . *on your own roads.* Ask him today! R. G. LeTOURNEAU, INC., Peoria, Illinois, Stockton, California. Cable Address: "Bobletorno."



## LETOURNEAU

### CARRYALL SCRAPERS

Angledozer\*, Buggies\*, Bulldozers, Carryall\* Scrapers, Cranes, Drag Scrapers, Power Control Units, Rooters\*, Treedozer\*

\*Name registered U. S. Patent Office.

# Get under Winter's skin

## ...WITH "CATERPILLAR" DIESELS!

**N**O MATTER how thick the Winter's skin gets, you can peel it back and toss it aside . . . quickly, efficiently and economically . . . with "Caterpillar" Diesels!

Here, in the "Caterpillar" Diesel line, is the *right* equipment for *any* snow. Do you have to battle big, wet drifts—piled deeper than a man is high? For a snow like that, or worse, you usually need the heavy pushing-power of a "Caterpillar" Diesel Tractor. On the other hand, less severe snowfalls

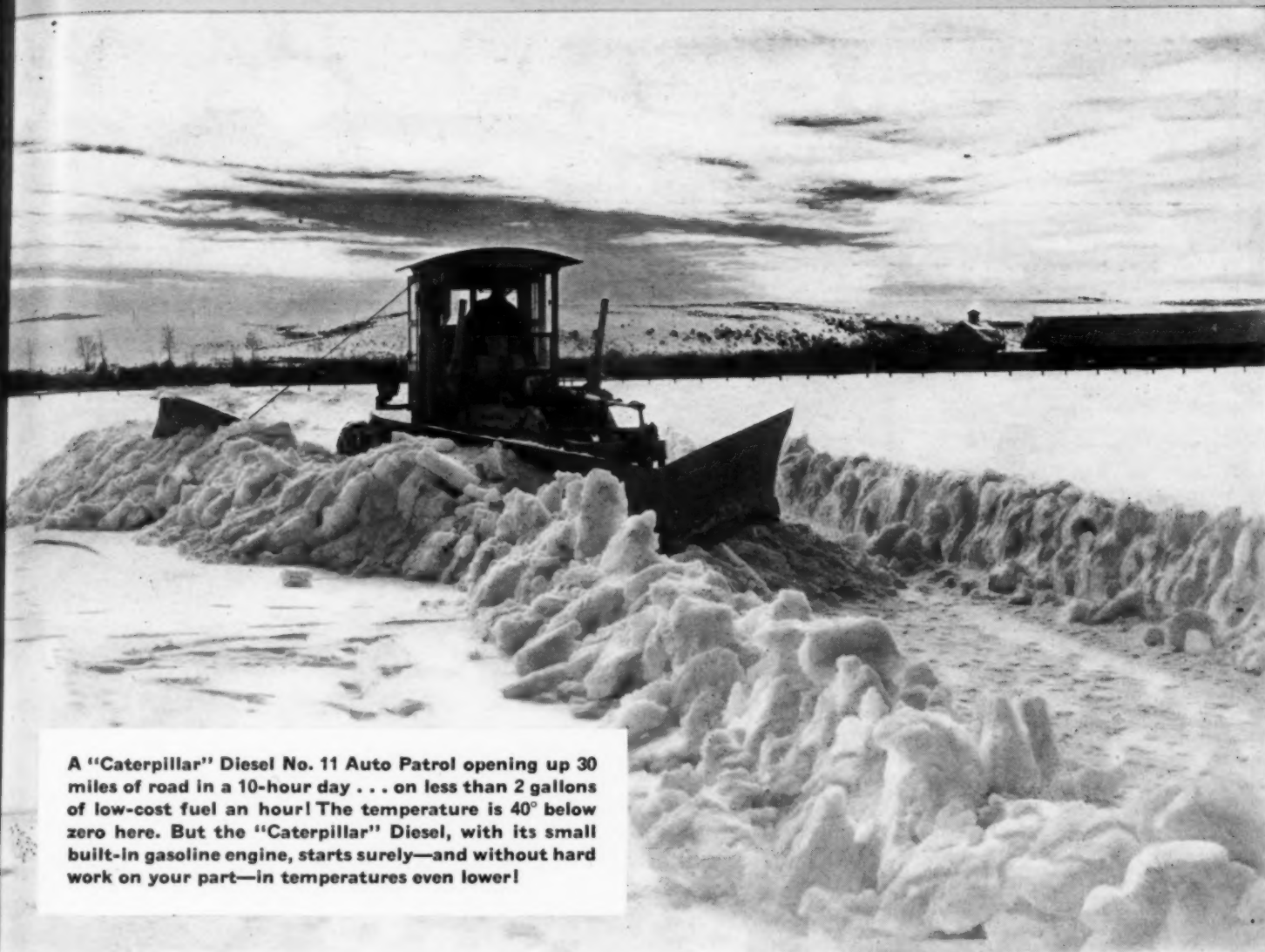
can be speedily and cheaply removed with a "Caterpillar" Diesel Auto Patrol!

Choose your snow equipment according to your needs. But make your choice from "Caterpillar" Diesels. Depend on their sparing use of low-cost fuel . . . moderate maintenance costs . . . ample traction . . . tremendous power . . . to make this one of the easiest Winters you ever went through!

And when Spring comes you can put them to restoring the roads . . . repairing shoulders and ditches . . . scarifying, blading, grading . . . building roads where roads have never been before . . . *at a lower cost-per-mile than you ever paid before!*



Six feet of snow giving way before a "Caterpillar" Diesel D8 Tractor with a LaPlant-Choate snow-plow. This outfit opens up 12 miles a day on only 3½ gallons of 11-cent fuel an hour. And it's working in Rocky Mountain snow!



A "Caterpillar" Diesel No. 11 Auto Patrol opening up 30 miles of road in a 10-hour day . . . on less than 2 gallons of low-cost fuel an hour! The temperature is 40° below zero here. But the "Caterpillar" Diesel, with its small built-in gasoline engine, starts surely—and without hard work on your part—in temperatures even lower!

## A NEW-TYPE MOTOR-GRADER!

### THE NEW, HEAVIER "CATERPILLAR" DIESEL No. 12 AUTO PATROL

Here is a machine that hasn't yet had a real chance to show what it can do on heavy snows. It was first offered for sale only a few months ago. But it quickly proved itself as a road-builder and maintainer! And with its greater weight, increased traction, and wider blade-scope it will prove equally efficient as a snow-remover.

Powered by a 66-horsepower "Caterpillar" Diesel Engine, this

new Auto Patrol has six forward speeds. It is suited for heavy ditch cuts, high-bank cuts and all types of construction and maintenance work. Its blade is fully revolving and capable of an almost unlimited range of positions. Power controls may be operated at two speeds. Steering is easier and more accurate than with any other motor-grader! See your nearest "Caterpillar" dealer for further details concerning this great machine.

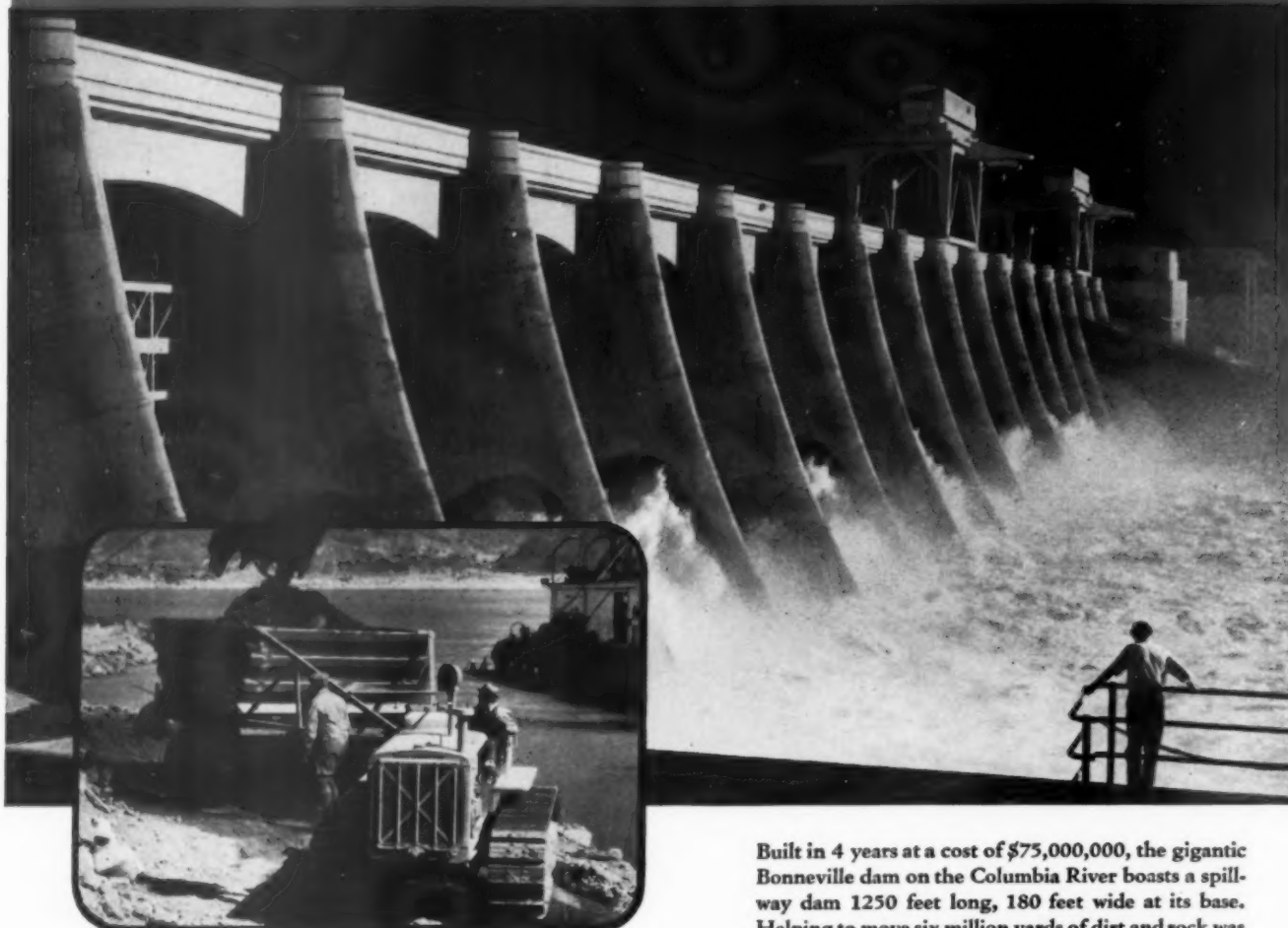


# CATERPILLAR

## TRACTOR CO., PEORIA, ILL.

DIESEL ENGINES • TRACK-TYPE TRACTORS • ROAD MACHINERY

# *Harnessing* THE COLUMBIA RIVER

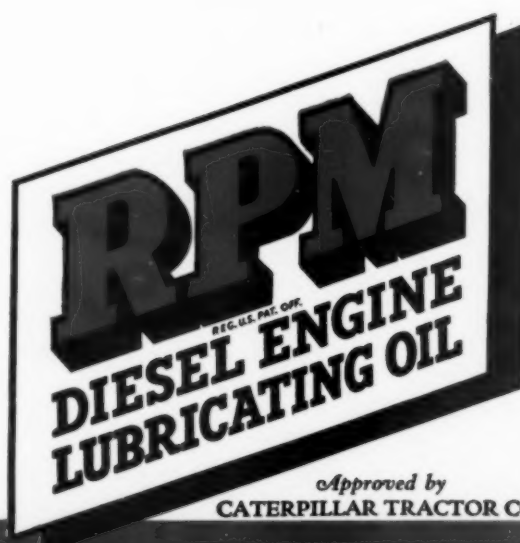


Built in 4 years at a cost of \$75,000,000, the gigantic Bonneville dam on the Columbia River boasts a spillway dam 1250 feet long, 180 feet wide at its base. Helping to move six million yards of dirt and rock was an important part that "RPM" Diesel Engine Lubricating Oil played in this outstanding engineering feat.

A REMARKABLE PROJECT needed a superior oil! And so—"RPM" Diesel Engine Lubricating Oil went to work! This world-famous lubricant was chosen for the "Caterpillar" Diesel tractor and compressor engines on the great Bonneville navigation-power dam project.

And no wonder! It keeps operating costs down—eliminates ring-sticking—reduces overhauls for carbon removal. That's why "Caterpillar" Diesel Engine operators everywhere depend on "RPM" Diesel Engine Lubricating Oil.

Make it the oil for *your* "Caterpillar" Diesel equipment. It not only maintains low oil consumption but holds engine wear to a minimum. You'll find out why "RPM" Diesel Engine Lubricating Oil is the world's *first choice* for "Caterpillar" Diesels.



Approved by  
CATERPILLAR TRACTOR CO.

**STANDARD OIL COMPANY OF CALIFORNIA**



On construction jobs, in power plants, in the woods and on the farm, "RPM" Diesel Engine Lubricating Oil is helping Diesel tractor owners to earn more profits.

It is made to prevent ring-sticking, reduce non-operating hours and end overhauls for carbon removal. When drained it removes dirt and carbon which it holds in suspension.

If your equipment is "Caterpillar" Diesel, this is your oil. "RPM" Diesel Engine Lubricating Oil is distributed by the following companies under the brand names indicated:

#### IN THE UNITED STATES

##### "RPM" Diesel Engine Lubricating Oil:

THE CALIFORNIA COMPANY (Montana only)  
THE CARTER OIL COMPANY, Tulsa, Oklahoma  
HUMBLE OIL & REFINING COMPANY  
STANDARD OIL COMPANY (Indiana)  
STANDARD OIL COMPANY (Inc. in Kentucky)  
STANDARD OIL COMPANY (Nebraska)  
STANDARD OIL COMPANY OF CALIFORNIA  
STANDARD OIL COMPANY OF TEXAS  
UTAH OIL REFINING COMPANY

##### Diol "RPM" Diesel Engine Lubricating Oil:

COLONIAL BEACON OIL COMPANY, INC.  
STANDARD OIL COMPANY OF LOUISIANA  
STANDARD OIL COMPANY OF NEW JERSEY  
STANDARD OIL CO. OF PENNSYLVANIA

##### Signal "RPM" Diesel Engine Lubricating Oil:

SIGNAL OIL COMPANY

##### Sohio "RPM" Diesel Engine Lubricating Oil:

THE STANDARD OIL COMPANY (Ohio)

#### IN CANADA

##### "RPM" Diesel Engine Lubricating Oil:

IMPERIAL OIL COMPANY LIMITED  
STANDARD OIL COMPANY OF BRITISH  
COLUMBIA LIMITED

#### THROUGHOUT THE WORLD

"RPM" Diesel Engine Lubricating Oil is also available through distributors in more than 100 other countries.

Get in touch with your nearest distributor—for a clean engine, and long hard service with the minimum of overhaul.



engineers should be men trained in this field, but it is hard to see where they are coming from. Our colleges are far behind in providing the right kind of training. The work is sporadic and not well organized, and a lot of it is centered on training traffic officers and not traffic engineers, and there is a vast difference between the two. It is going to be necessary to educate our educators to educate traffic engineers and even we engineers may have to be educated to the fact that in this work some of the old mummified "fundamentals" are not as fundamental as we think. To the traffic engineer psychology may be more important than mathematics, physics, or mechanics. Now you traditionalists hold up your hands in holy horror!

Possibly you have gained the idea that I am trying to make out that the engineer is nothing but a long series of faults. This is by no means true. I am merely trying to point out some of the *handicaps* he has to overcome in doing his work as it should be done. The very fact that they are handicaps proves that the engineer has a large array of fine characteristics and indispensable qualities of a high order. Chief of these is, perhaps, the ability to think clearly, to play mental golf, as it were. A slow, full backswing to marshal the facts and conditions, a powerful downswing to concentrate sound logic on the problem, and a long follow through to maintain the desired direction and reach the proper conclusion. The salvation of this country lies in her engineers preserving, enlarging, and spreading his ability to think clearly, for never has our nation needed clear thinking more than at present.

*Acknowledgment*—The foregoing is an abstract of a paper presented at the 1938 Conference on Highway Engineering at the University of Illinois.

#### A. G. C. FALL BOARD MEETING DISCUSSES LABOR RELATIONS

Problems in labor relations in the highway field have been multiplied many times this past year. Opinion expressed at the Fall meeting of the Board of Directors of the Associated General Contractors which was held last month at Excelsior Springs, Mo., indicated that there is no reason to believe that this trend will not continue.

In October the American Federation of Labor went on record as favoring the extension of the Bacon-Davis Prevailing Wage Law to all construction work in which the Federal Government has a financial interest. This would, of course, include federal highway aid work, and should this proposal prevail, it would mean that the wages on Federal Aid work would be fixed, not by the State as at present, but by the Secretary of Labor. What this means one may easily deduce for himself.

It was reported that the Highway Division has endeavored in every way possible to combat the inroads of WPA. Considerable discussion was given to the day labor menace and to the modified contract—WPA labor method of construction.

J. S. Harrison, Senior Highway Engineer of the U. S. Bureau of Public Roads, discussed the variation in pre-qualification requirements, indicating the need for greater uniformity.

**EXAMINATION FOR CHIEF ENGINEERING DRAFTSMEN**  
—The U. S. Civil Service Commission, Washington, D. C., has announced an examination to fill the position of chief engineering draftsman at \$2,600 per year. Applications must be on file by Dec. 19.

# EDITORIAL

## ABOUT EQUIPMENT SALES POLICIES

WE thought the accompanying drawing (which is published by permission of The Stevens-Davis Company of Chicago) was particularly appropriate in view of some present day tendencies in construction equipment selling. The tendencies are those which are quite unhealthy for the manufacturing industry and the construction industry as well. We refer to the selling of construction equipment on a basis which practically amounts to financing a contractor. In reality it is renting new construction equipment rather than selling.

The charge has been made that some manufacturers are selling equipment, sometimes direct and sometimes



through distributors, to any contractor who may own a broken down truck and be able to low-bid a job. To the reputable contractor, properly financed, well organized, and able to pay cash, this practice is unfairly discriminatory. Manufacturers should be in the equipment manufacturing business, not in the loan and collection business.

On the other hand, one may readily sympathize with the sales manager, indicated by the drawing, who is forced to meet the competition of other manufacturers that pursue the unreasonably long term equipment financing procedures. The tendency for a contractor to overequip in order to meet other contractors in competitive bidding is tremendously enhanced when he can get new units on a low rental basis. Sooner or later the practice of long term financing or renting will lead to a manufacturers' war with no good results to either the manufacturer or the contractor. Sooner or later the contractor will find himself loaded down with a big equipment investment and no way to realize on it.

Used construction equipment does not have, proportionately, the same resale value as used cars. Used construction equipment that has no job on which to work is worth no more than so much junk.

It seems to us that bidders on all street and highway work—federal, state, county, or city—should be pre-qualified to the extent that they can show clear title to the equipment they expect to use or that they have enough cash to buy what they need but do not have. A note of warning was sounded at the Fall meeting of the Board of Directors of the Associated General Contractors that many highway contractors are overequipping. We cannot help but believe that manufacturers following the destructive financing policy which amounts to low rental, are responsible in a degree for this unhealthy trend. They are making purchase requirements too easy for the inadequately financed contractor, and in that way, discriminating against their responsible customers. Sooner or later the inadequately financed contractor will fail, and more likely sooner than later. Such failures are demerits against the industry, to say nothing of the hardships wrought on the life savings of the bankrupted contractor.

## CONTINUE THE HIGHWAY PROGRAM

INTEREST of state and county highway departments in a continued highway program is not a matter of personal and individual benefit. Many of them could quit the jobs on which they are now working and make more income in some other activity. With their statewide contacts they are in a position to interpret the wishes of the public. This interest in a continued highway program is a duty they owe to the people of the state in which they work. From them must come the factual information about highways and their value.

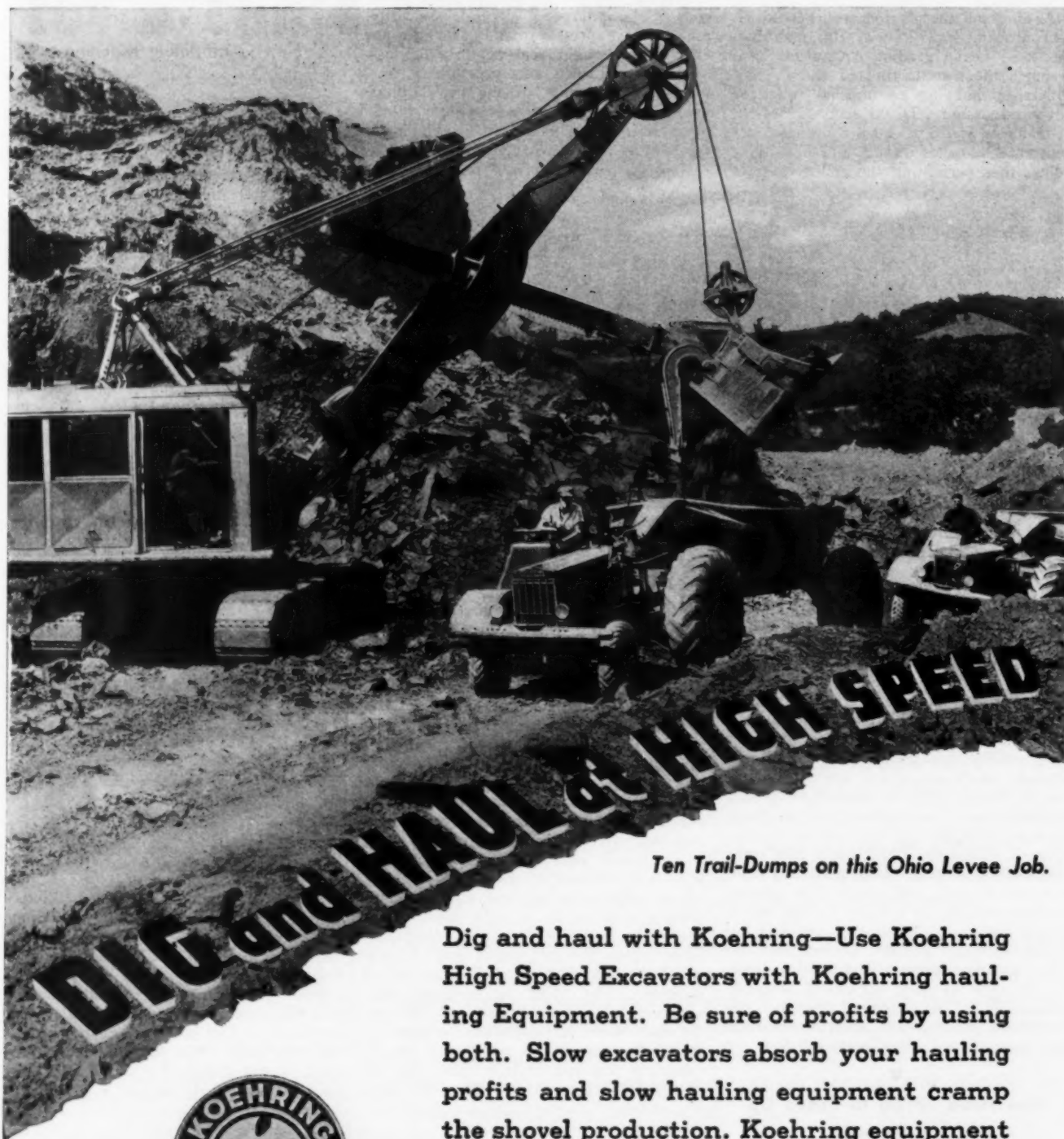
We may repeat about this subject just what was written about Initiative Measure No. 41 in Montana's lively "Center Line." "Not so very along ago the height of bucolic wit and sarcasm was to heckle some stranded pioneer motorist with the yelp, 'Get a horse.' Now, everyone, regardless of age, race, or previous condition of servitude is echoing the classic words of Sir Walter Raleigh when he spread his best velvet coat in the mud for Queen Elizabeth to walk across. The gallant Walter murmured, 'Step on it, kid.'"

"Ten or twenty years ago every community had a 'Good Roads Jones' or a 'Good Roads Smith' who either adopted the monicker for political purposes or was tolerantly regarded as a harmless fanatic.

"Today modern highways are a necessity and the outgrowth of popular demand. *Let that be clear.* POPULAR, according to Mr. Webster meaning, 'pertaining to, suitable for, or pleasing to the common people,' and DEMAND meaning, 'to claim as by right or authority.'"

Such being the case, highway engineers and highway contractors are fully justified, from other than a selfish point of view, in promoting a continued highway program. They should talk it, write it, and explain it to those who are influential in its preservation.

# KOEHRING



*Ten Trail-Dumps on this Ohio Levee Job.*



Dig and haul with Koehring—Use Koehring High Speed Excavators with Koehring hauling Equipment. Be sure of profits by using both. Slow excavators absorb your hauling profits and slow hauling equipment cramp the shovel production. Koehring equipment is fast, economical and steady in operation. Many leading contractors are insuring their profits with Koehring equipment.

**KOEHRING COMPANY**  
CONSTRUCTION EQUIPMENT • MILWAUKEE, WISCONSIN

## NEW EQUIPMENT AND MATERIALS

### New Sheep's Foot Roller

A different sheep's foot roller! R. G. LeTourneau, Inc., Peoria, Ill., manufacturers of heavy grading equipment, have resumed the manufacture of sheep's foot rollers by building an unusual roller of advanced design. Drum sections  $3\frac{1}{2}$  ft. in diameter and 5 ft. long, are hinged together to allow oscillation and easy flexibility, thus permitting the rollers to fol-



*New Sheep's Foot Roller*

low the contour of uneven ground and give uniform compaction at all points. Due to the unusual hinging, any drum in the roller may be interchanged with any other drum. This feature makes it easy to convert a 2-drum roller into a 4-drum roller and vice versa. Likewise, these sections can be placed in tandem where additional compaction is required. The tamping feet are not the conventional straight shaft shape, but are tapered; a special design that is claimed to permit stronger base construction and to make it more difficult for the feet to become clogged. Because of the shape, they enter the new fill material easily, give maximum compaction, and pull out of the ground without kicking or tearing up the newly rolled material. These feet are 8 in. in length—giving deeper penetration—and have a larger area welded to the drum, which adds to their structural strength. Durability is also assured by the LeTourneau patented box beam construction and heat-treated, hard-surfaced feet.

### New Head Fitting to Speed Up Lubrication

A new, free-flow giant Alemite button head fitting, designed to speed-up the lubrication of heavy machinery, has been announced by the Stewart-Warner Corporation, Chicago, Ill. Bearings requiring large amounts of lubricant—such as those on tractor track rolls—can be lubricated in less time than with older types of fittings, and with less chance of damage to grease gun equipment through overloading, the manufacturer states. In the new fittings, the usual valve core has been

replaced with one which has a flat face and seat, and which, when open, offers practically no impediment to the free flow of lubricant. By expanding the diameter of the valve retaining-spring, lubricant flows unobstructed through the center of the spring and not through its compressed coils. The improved valve opens easily under slight pressure, and provides an effective and tight seal against the loss of lubricant when the pressure is removed. The bodies of the new fittings are hardened to withstand rough treatment. Their smooth tops, which eliminate the cutting or wearing of the coupling sealing washer, are a new feature.

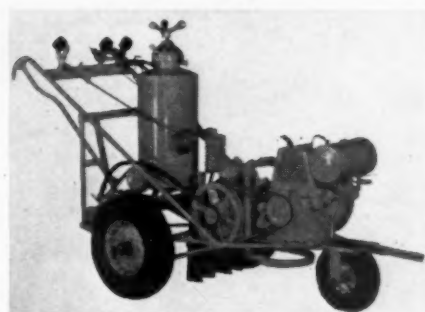
ing the length of two telescopic shafts, that rigidly support the wide end of the wing, the angle of cut or tilt can be changed to suit any snow condition. Rear wing supports are secured to the bumper with U-bolts while the forward bracing is bolted to the grader frame.

### New Centerlining Machine

A line of centerlining equipment employing the recently perfected and exclusive Kelly-Creswell air curtains, which maintain the straight-edges of the lines by means of a current of compressed air or exhaust gas distributed from a manifold through especially designed slots in the guide plates, which are carried about  $1\frac{1}{2}$  in. above the surface of the highway, has been placed on the market by the Kelly-Creswell Co., Xenia, O. Inasmuch as no part of the spray assembly comes in contact with surface, it is claimed that the same keen-cut straight-edges can be maintained over any type of surface, smooth or rough. Air flowing through the guide plates constantly keeps any material from collecting on them and therefore eliminates any dragging out of paint at the end of intermittent lines. A semi-internal-mix spray head developed by The DeVilbiss Co. exclusively for Kelly-Creswell delivers a completely atomized spray with perfect cross distribution. An especially designed needle-valve delivers a square

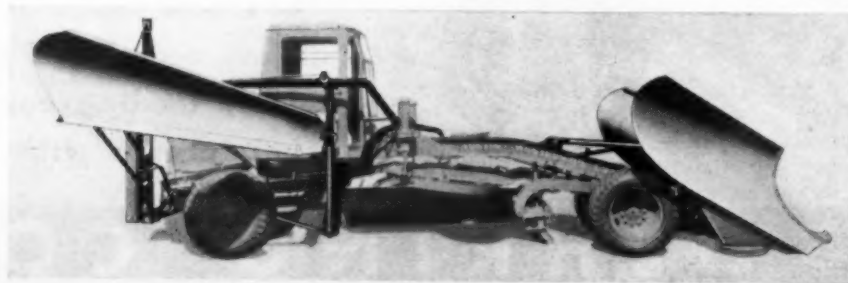
### New Plow and New Snow Wing

A new giant V-plow and a rear mounted snow wing for use on the "99" motor grader are two new products of the Austin-Western Road Machinery Co., Aurora, Ill. The V-plow is designed to use the 4-wheel drive and steer advantages of the "99" to remove the deep snow at higher speed. This plow is stated to "cut under" as it pierces the drifts, elevating the snow over its long curved moldboards, with a minimum of resistance, and finally throwing it outward—to clear the plow. The rear-mounted Austin-Western snow wing is a capable auxiliary unit for moving piled snow farther to the side, for clearing up after plowing, and also for handling a wide swath of light snow. It is operated hydraulically, and controlled from within the cab, either end of wing can be raised or lowered to any desired position. The wing is mounted independently of the moldboard and does not interfere with its operation or that of the circle; the grader moldboard can be raised or lowered, shifted either way or reversed in the customary way. By vary-



*Kelly-Creswell Centerlining Machine*

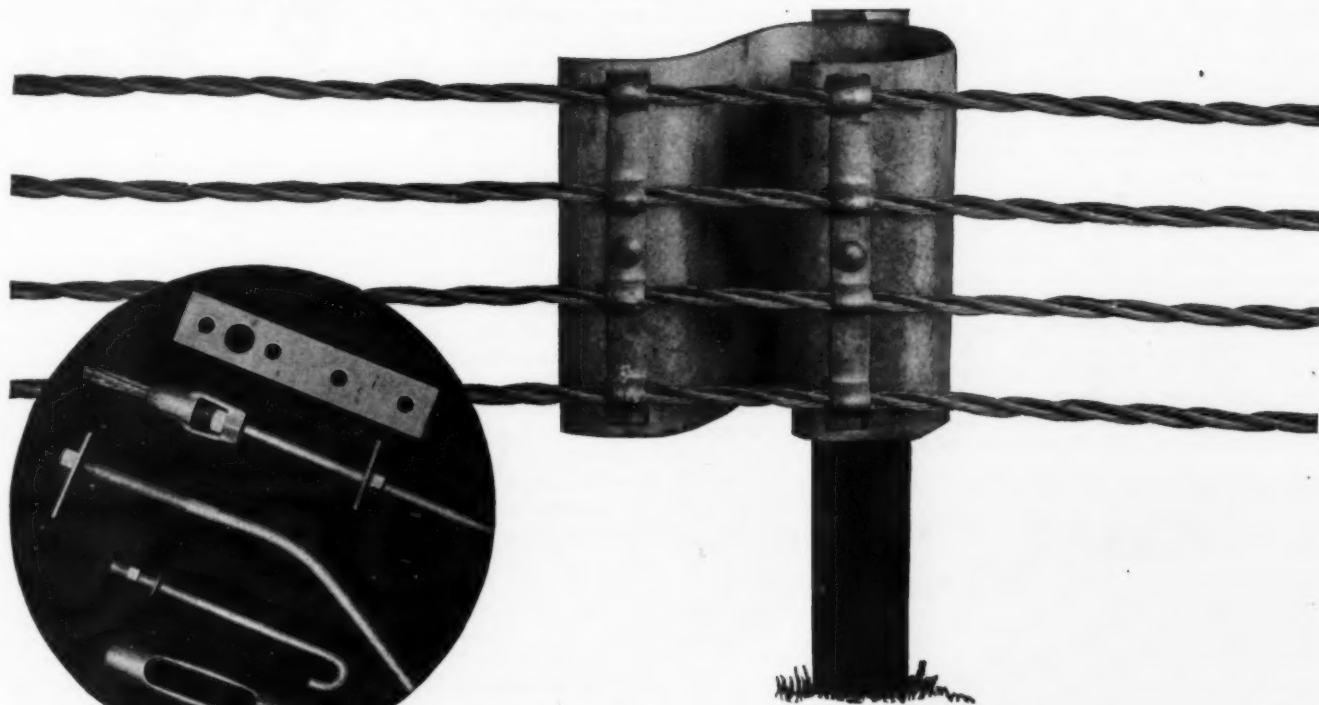
opening and a square cut-off for intermittent lines while the machine is in motion. Width of the line is instantly adjustable between 2 and 7 in. The paint volume is controlled both by regulated pressure on the material container and by adjustable compression lever under left handle-bar. The principal claim for the machine, aside from the air curtain feature, is the elimination of heavy-edged lines. Traction at variable speeds up to



*Rear-Mounted Snow Wing*

# EVERYTHING

## for a cable guard rail



## from one manufacturer

### BETHLEHEM PRODUCTS FOR HIGHWAY BUILDING

BAR MATS      WELDED WIRE FABRIC  
CONTRACTION JOINTS (Road Strip)  
STEEL REINFORCING BARS      DOWELS  
BAR TIES      HIGHWAY GUARDS  
BETHLEHEM STEEL H-PILING  
BETHLEHEM STEEL SHEET PILING  
MISCELLANEOUS PRODUCTS

BETHLEHEM STEEL COMPANY, General Offices:  
Bethlehem, Pa. District Offices: Albany, Atlanta,  
Baltimore, Boston, Buffalo, Chicago, Cincinnati,  
Cleveland, Columbus, Dallas, Detroit, Honolulu,  
Houston, Indianapolis, Johnstown, Pa., Kansas City,  
Mo., Los Angeles, Milwaukee, Nashville, New  
Haven, New York, Philadelphia, Pittsburgh, Port-  
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Antonio, San Francisco, Savannah, Seattle, Syra-  
cuse, Toledo, Tulsa, Washington, Wilkes-Barre,  
York. Export Distributor: Bethlehem Steel Export  
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**BETHLEHEM** makes complete cable guard-rail equipment—every fitting required as well as the cable itself. A single order placed with Bethlehem brings you everything—cable, cable fittings, anchor rods, turnbuckles, special and standard bolts and nuts, steel braces and steel posts. This equipment is adaptable to any and all State specifications as to type of bracket, number of cables, end adjustments and anchorage.

Of increasing interest to contractors is the steel post—the only type of guard-rail post that can be driven instead of set. Even though somewhat higher than wood posts in initial cost, it actually costs less, installed, in most localities. It is delivered to you ready to use. It requires no seasoning, of course. It is drilled. It already has a priming coat of paint. And it can be driven by sledge or by an air hammer with adapter head. It is the easiest type of post to align.

Whenever special problems arise—as to what meets State specifications, or as to specially designed cable guard rail to meet unusual safety requirements—get in touch with Bethlehem's nearest office. A specialist in guard-rail problems is at your service.

*For a convenient and dependable supply of road steel, utilize Bethlehem's road steel service.*

## BETHLEHEM STEEL COMPANY



three miles per hour is effected by the use of friction pulleys mounted on a fixed counter shaft and actuated by compressed air, which eliminates wobbling over rough surfaces and a very sensitive governor maintains a constant speed, both up hill and down. The entire spray operation is entirely visible to the operator through the tubular steel frame and an adjustable guide arm makes it easy to lay a new line or retrace an old one. The Kelly-Creswell Co. is anticipating placing on the market by the first of the year a small hand-propelled unit, with side-delivery spray assembly, designed especially for municipal use, also a complete truck set-up with unlimited air capacity for high-speed operation.

#### New Snow Plow

The Hercules Steel Products Co., Galion, Ohio, announces the manufacture of a quick-reversible snow plow with electrically operated hydraulic lift. This plow, for 1½ and 2 ton trucks is known as the "Hercules Model A snow plow." This plow uses a Meyer safety blade, which enables the plow to scrape directly on the pavement. The blade operates as



*New Hercules Model A Snow Plow*

a safety trip, riding the plow over ordinary road obstructions without the use of springs or other tripping devices.

#### New Concrete Mixers

Four wheel 7-S and 10-S mixers have been added to the line of side loading mixers of Gilson Brothers Co., Fredonia, Wis. These machines, as well as the Gilson Co.'s other models, are equipped with hydraulic skip hoist and shaking mecha-



*New Gilson Bros. Co. Mixer*

nism. Among the advantages claimed are: The ability to raise the skip at a greater vertical angle; very rapid and clean discharge into the mixing drum obtained through the positive and adjustable shaking valve; simplification of parts and the number of places to be lubricated; the ability to shovel into the side of the skip without interference from cables; considerable more compactness; greater neatness in appearance. It is also the contention of the manufacturer that as there are no brakes or clutches to be adjusted and all parts are well guarded that another advantage is the element of greater safety.

#### New 30-Yard Scraper

A 30 yd. carryall scraper has been added to the line of R. G. LeTourneau, Inc., Peoria, Ill. Expended tractor effort is reduced and the payloads increased by the LeTourneau patent sliding bucket of the Model U. This same exclusive feature combined with the use of the pusher, and a special cutting blade have shortened loading time and distance. The scientifically designed blade has speeded up cutting by boiling the dirt into the bowl naturally due to the plow-like angle and the correctly shaped edge. Fractional inch cutting and controlled spreading are secured through the cable action of the power control unit. In dumping loads can be spread to a measured depth of 24 in. Dumping is facilitated by a new sheave arrangement that handles the heavy load through the cable action transmitted by the power control unit. These sheaves are placed on the side and designed to relieve the strain on the tailgate from the extra yardage in the bowl, reduce the cable wear, and protect the cable from the dirt. The cables running over the top of the load are run through tubular housings for

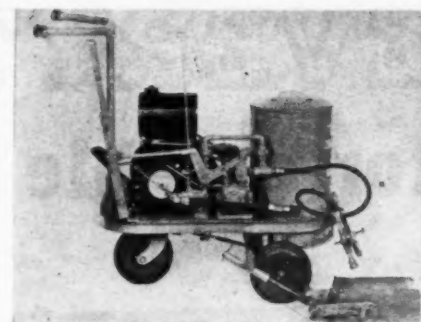


*New RU 30-Yard Carryall Scraper*

protection against the abrasive dirt. Draft has been greatly reduced by placing two large 24 x 32 tires, 80 in. high, on the rear. Four 18 x 24 tires are used on the front. Heaped capacity of the carryall is 30 yd. and struck 22.2.

#### New Zone Marking Machine

A new zone marker has been brought out by the General Iron & Steel Corp., 276 Lafayette St., New York. This marker will paint a single traffic mark from 2 in. to 8 in. in width. It is a "one man" machine with a one-lever con-



*The Gisco Zone Marker*

trol. Pressure for painting is obtained by pumping the paint with a specially designed pump driven by a 1 H.P. gasoline engine. There are no gauges or relief valves used. The action is simple and positive. An important feature is that the paint is being agitated while the machine is being used. Approximately four-fifths of the paint is discharged back into the tank; the other fifth is pumped with force through a specially constructed stainless steel disc. Through an ingenious arrangement, the operating lever does not at any time stop the flow of paint, but only changes the direction of flow. One position of the lever causes the paint to be discharged through the disc, while at the other position of the lever, the direction of flow throughout the system is in the reverse direction, i.e., where paint was discharged through the disc, now air is drawn in under the full pressure of the pump. This sweeps the disc and its supply line completely clear of paint. This action removes any possibility of drip. While in this position the machine can be completely cleaned by removing the jet-line and inserting it in solvent or thinner,

allowing the machine to operate until the fluid that comes back into the tank becomes perfectly clear. The pump has been specially designed and built by Viking. Two adjustable, oscillating steel shoes determine the width of the line. This assembly is so constructed that the line will have a sharp edge. The thickness of the paint applied is determined by the operator, who controls it by adjusting a simple valve within his easy reach. The nozzle consists of a brass fitting holding a flat stainless steel disc, which causes the paint to issue a flat spray.

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### New Truck Shovel

A new truck shovel and/or crane mounting weighing only 12,500 lb. has been announced by the Hanson Excavator Works, crane and shovel division of the Hanson Clutch and Machinery Co., Tiffin, O. This

and the number of amperes for each and every setting. Another feature of this welder control is that both voltage control (job selector) and current control are continuous in operation. This design provides literally thousands of possible



*Hanson Comet Mounted on FWD Truck*

Hanson known as the "Comet" for truck mounting, available as shovel, crane, clamshell or dragline is equipped with Hanson patented Lockheed hydraulic controlled clutches and brakes. The Hanson "Comet" is constructed so that any clutch shoes or shaft assemblies may be removed without disturbing any other part of the machine. Simplicity and get-at-ability being one of the fine engineering points of all Hanson rigs built in  $\frac{3}{8}$  yd. to  $\frac{3}{4}$  yd. capacities.

### New "Shield-Arc" Arc Welders With Self-Indicating Control

A line of "Shield-Arc" welders, said to provide greater convenience and accuracy because of a new self-indicating dual continuous control, is announced by The Lincoln Electric Co., Cleveland, O. These welders have both job selector and current control calibrated and equipped with dials which indicate the type of work

combinations of voltage and current. Being continuous, the control can be advanced or retarded in increments as fine as desired. Other features of this new line of Lincoln Welders include: A self-protected motor on all AC motor driven welders. Separate excitation of the welding generator in all types of these new welders provides the generator with a constant source of excitation which is independent of conditions at the welding arc. A laminated magnetic circuit is employed in all types of welders providing minimum reluctance to the flow of magnetic flux. This new line of Lincoln Welders is available in AC and DC motor driven types, belted or coupled type, and in gasoline engine and diesel engine driven types, in all standard ratings.

### New Luminaire for Highway Lighting

New features—die-cast aluminum hood, fluted reflector, and new refractor—have been added to the original General Electric Form 79 Luminaire for street lighting, which was introduced approximately three years ago by the General Electric Co., Schenectady, N. Y. The new hoods are lighter, stronger, and present a better appearance than sandcast hoods. Ordinarily furnished tapped for  $1\frac{1}{4}$ -in. pipes, they are available tapped for 2-in. pipes. The tilted flutes of the reflector, in addition to assuring improved efficiency and light control, result in better lamp performance through lower temperatures inside the lamp. The new refractor means better light distribution and utilization. The spun-on globe which is used with

the Form 79 has set a record for low breakage rate. Comparisons show that the breakage of ordinary types are from 10 to 20 times as great as that of those spun-on, dustproof globes. Performance facts about the new unit, together with an explanation of structural details which assure such performance, are included in the new G-E publication, GEA-2276B.

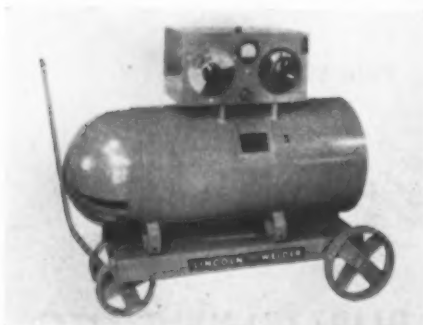
### New Special Marsh Truck

The 1939 line of All-Wheel-Drive Trucks manufactured by the Marmon-Herrington Co., of Indianapolis, Ind., includes a new and "special" model of the all-wheel-drive marsh buggy, first introduced last summer. The marsh buggy is now a regular production unit in the Marmon-Herrington line, the latest consignment of these vehicles going to Asia Minor. Fundamentally, the marsh buggy is a Marmon-Herrington all-wheel-drive Ford truck, especially engineered to accommodate the mounting of from four to ten 13.50x24 tires. The number of these tires furnished with the Special Marsh Buggy varies in accordance with the type of terrain in which the vehicle is to operate. For less extreme conditions single tires front and rear are furnished, but for the deeper more difficult marshland



*Marmon-Herrington All-Wheel Drive Special Marsh Buggy*

ten tires are supplied, three on either side in the rear, and two left and two right in the front. Much engineering had to be done, of course, to provide proper axles and gear ratio for these extremely large wheels, and structural changes were necessary on the Ford truck chassis. How well all of this has been done is proved by the remarkable ability of the Marsh Buggy, on highways as well as in the softest kind of going. In reality, the Marsh buggy combines the great tractive ability of Marmon Herrington all-wheel-drive, applied to the enormous tire surface of the ten big tires, with the remarkable "flotation" effect gained by these same big tires. The vehicle actually seems to paddle its way across marshlands which cannot be traversed by boat, by men or animals, nor by any other type of production vehicle. The Marmon-Herrington Company builds a complete line of four and six-wheel all-wheel-drive trucks and truck-tractors with load capacities up to 25 tons, and in addition, converts all Ford trucks, passenger and commercial cars to all-wheel-drive.



*New "Shield-Arc" Welder, AC Motor Driven Type*



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Blaw-Knox is the only manufacturer offering complete equipment for ready mixed concrete; including Trukmixers and Agitators, Ready Mixed Concrete Plants and Truck Mixer Loading Plants of all capacities and types.

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R. B. ZEIGLER, Manager

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## SAVE UP TO \$1925 ON YOUR BITUMINOUS SPREADING AND PAVING EQUIPMENT

To meet a liquidation deal we are authorized to offer the below listed factory-rebuilt machines, with full one-year guarantee, at these greatly reduced prices and special terms:

- (1) \$500 down payment holds any machine for spring delivery—balance in monthly notes to September 1, 1939.
- (2) Or we will allow 5% discount for cash purchase.

One 1936 Model Jaeger  
9-12 Ft. Bituminous Paver,  
with semi-crawler wheels,  
oscillating screed, blending  
wings for finishing up to  
curb, etc.

**\$2750**



One 1937 Model Jaeger 9-12 Ft. Bituminous Paver with patented "hot oil" heated screeds adapted for all types of work, including sheet asphalt. Full oscillating, heated blenders, semi-crawler wheels. (Additional adjustment for 14 ft. widths available.) Used on only one job. Cost new, \$5675.

Can be bought for only . . . . . **\$3750**



One Jaeger Mix-in-Place Road Builder, tractor pulled, complete with 75 H. P. engine and leveling device for laying perfect riding roads. For building up to 2" retreads. Widely used for re-

treading old roads of all types and for stabilization work. Records of up to 2 miles of finished 22 ft. road in one day have been laid with this machine. Original cost, \$4950. Machine is just like new. Now priced . . . . . **\$3350**

Heavy Duty Pugmill Mix-in-Place Road Builders, self-propelled, for stabilization and heavy mat work up to 16 cu. ft. windrows. Both new and used machines for sale and rent.

Above Equipment Offered Subject to Prior Sale  
— Phone, Wire or Write Us.

**THE JAEGER MACHINE COMPANY**  
223 Dublin Ave. Columbus, Ohio

### Snow Plow Attachment for Power Lawn Mower

The pneumatic-tired Toro Park Special power lawn mower of the Toro Manufacturing Corporation, Minneapolis, Minn., with the cutting unit removed can now

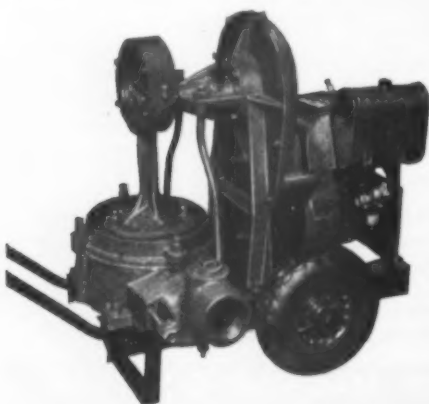


*Lawn Mower with Snow Plow Attachment*

be equipped with a thoroughly efficient snow plow 51 in. wide and 21 in. high adjustable to various angles and levels. The plow is easily turned and with slight pressure on the handles the blade lifts off the ground. A revolving brush is also available which enables an operator to plow and sweep a skating rink in one operation. These new attachments now make it possible for one machine to mow grass in summer and plow snow in winter.

### A New, Light-weight Diaphragm Pump

A new, light-weight, compact, 3-in. diaphragm pump has been announced by the Novo Engine Co., Lansing, Mich. This new pump has completely enclosed gearing and a double braced eccentric which transmits the power to the pump, replacing the old cumbersome walking beam. A husky, 2½ H.P., air-cooled anti-friction engine is close coupled to the pump. This is a standard A.G.C. 3 in. closed top pump with standard rating of 3,000 G.P.H. at

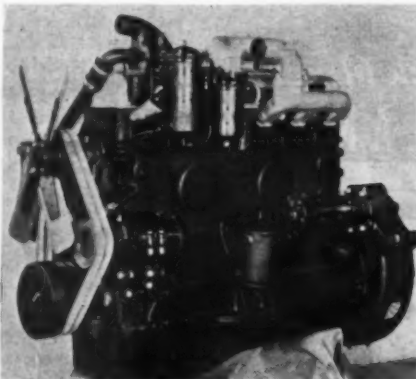


*New Novo 3-in. Diaphragm Pump*

10 ft. suction and 1,500 G.P.H. at 20 ft. suction. Particular attention has been paid to accessibility. Removing four brass nuts permits inspection of both the suction and discharge valves. Two additional nuts remove the diaphragm. The pump, skid mounted, weighs only 370 lb. It can be mounted on a two wheel, steel or pneumatic tired truck. A 4 in. model is to follow.

### New Diesel Engine

A diesel engine of its own manufacture was exhibited by Mack Trucks Inc., Long Island, N. Y., at the National Motor Truck Show. It has been known for some time that Mack was shortly to announce its diesel, preliminary models having been on the road in various lines of actual service for some time. As a matter of fact this particular engine is stated to represent the culmination of 8 years of development, during which time Mack engineers have studied the diesel from every angle, both in this country and abroad. The Lanova energy-cell combustion system is used in the engine. At the present time the Mack-Lanova is being produced in a single size—519 cu. in. displacement—developing 131 h.p. at 2,000 r.p.m. Available at present



*Mack-Lanova Diesel*

on Models BM, BX, CJ trucks and Model CT buses, these engines are built completely in Mack shops, even the cylinder blocks, crankcases and cylinder heads being cast in Mack's own foundry. Numerous innovations have been incorporated in the design, but basically it adheres to the orthodox 6-cylinder vertical form and operates on the conventional 4-stroke cycle.

### New Two-Stage Regulators

The Linde Air Products Co., 205 East 42nd St., New York, Unit of Union Carbide and Carbon Corporation, has announced three new regulators: the Purox oxygen regulator, Type R-201 (for ordinary welding and light cutting); the Purox oxygen regular, Type R-202 (for heavy-duty cutting); and the Purox acetylene regular, Type R-203. These regulators utilize the principle of two-stage regulation. A fixed "first stage" reduces the pressure of oxygen or acetylene from cylinder pressure to a moderate figure, below which it is regulated by the variable second stage of regulation. Stem-type valve mechanisms insure a uniform flow of



*The Purox Oxygen Regulator, Type R-201*

oxygen and acetylene at the lower pressures at which the gases are used and in quantities sufficient for practically all welding and cutting operations. The Monel metal valve stems are distinct from the diaphragms, thus eliminating the possibility of stem distortion due to diaphragm pull caused by leakage. Accurately machined guides assure correct alignment of the stems. Heavy valve closing springs give positive seating action. A striking feature of the new regulators is their attractive sturdy appearance. The first- and second-stage caps are bullet-shaped, giving the regulators a "streamlined" effect.

### New Sodium Luminaire for Tunnels

An enclosed-type sodium luminaire with special advantages for use in tunnels, either where head room permits suspension from the ceiling or in a modified style, where recessing into the tunnel wall or ceiling is desired, has been developed by engineers of the General Electric Co., Schenectady, N. Y. Already installed in the McCallie Ave. tunnel, Chattanooga, Tenn., and in the Stockton St. tunnel, San Francisco, the new units will soon be in operation in the Liberty Tunnel, in Pittsburgh. Alzak aluminum reflecting surfaces in the luminaire hood assure a high utilization of the sodium light output over the tunnel pavement. An enclosing glass bottom door protects the reflecting surfaces from dust and material in the tunnel air which might be harmful. The sodium lamp, mounted horizontally in the unit, is effectively shielded from direct vision by the hood of the luminaire. A pivot mounting for the luminaire is available when complete shielding of the lamp is desired in one-way tunnels. The luminaire is equipped with a standard cathode preheating automatic resetting timer and with a radio interference suppressor. The luminaire mounting is arranged for both multiple or IL transformer connection to a series circuit, or with a high 10,000-lumen a-c sodium lamp, in conjunction with a 2-wall 70-G vacuum flask, is recommended for use in the enclosed-type luminaire.

# THIS 84-HD KETTLE HEATS TAR & ASPHALT FASTER



## LITTLEFORD

THE No. 84-HD Kettle contains two patented features which guarantee faster heating. They are "Double Heat Circulation" and "Screened Reservoir".

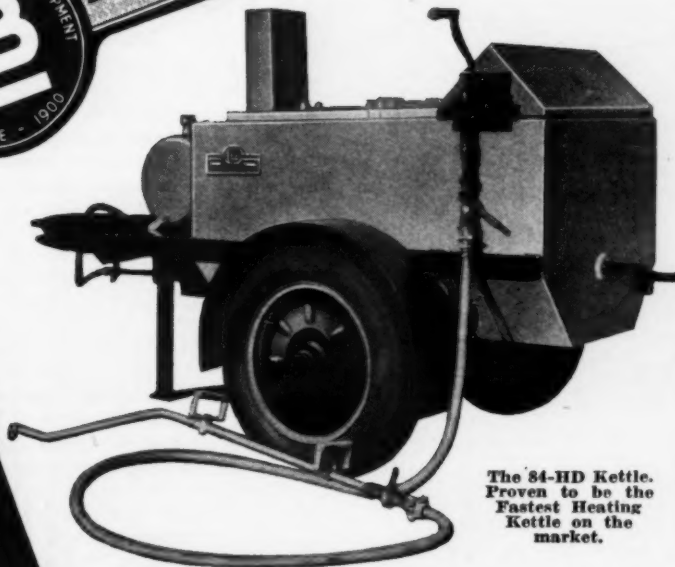
This "Double Heat Circulation" system makes it necessary for all heat from the burner to pass over the entire kettle producing uniform temperature throughout. This heats the tar and asphalt faster and saves on fuel.

The "Screened Reservoir" keeps the cold materials from the already melted material by means of an inverted V-type screen. This "Screened Reservoir" makes it possible for the user to have a continuous flow of hot material.

The No. 84-HD Kettle is one of the fastest heating and spraying pieces of equipment on the market.

**LITTLEFORD BROS.**

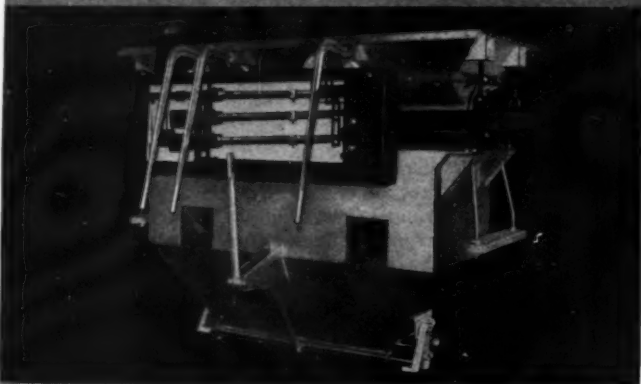
454 E. Pearl St., Cincinnati, Ohio



The 84-HD Kettle.  
Proven to be the  
Fastest Heating  
Kettle on the  
market.



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To quickly and accurately measure AGGREGATES, CEMENT AND WATER, Blaw-Knox Weighing Batchers are standard equipment in widespread use by road contractors, for general construction, material yards, and ready mixed concrete plants. They satisfy all modern specifications. Furnished for manual or automatic operation.

The reliability of Blaw-Knox Weighing Batchers is acknowledged by thousands of users. Send for Catalog No. 1566.

BLAW-KNOX DIVISION of Blaw-Knox Company  
FARMER'S BANK BUILDING PITTSBURGH, PA.

**BLAW-KNOX** Aggregates and Cement  
WEIGHING BATCHERS



Scrapping gravel from pit to crusher.



Sauerman Slackline moving river gravel to screening plant.

## SAUERMAN LONG RANGE MACHINES

Use a Sauerman Drag Scraper or Slackline Excavator to reduce your equipment cost and operating expense on such work as the following:

- making long cuts and fills
- canal and levee construction
- cleaning reservoirs
- digging gravel from rivers, hills and pits
- stockpiling and reclaiming gravel, coal, ore, etc.
- and other long haul work.

A Sauerman machine has a great advantage over other types of equipment on work of the above description because it is able to reach any distance up to 1500 ft. and dig, haul and place the materials in one operation.

For complete facts write for a copy of our 84-page catalog.

**SAUERMAN BROS., Inc.**  
488 S. Clinton Street CHICAGO

### New Portable Gasoline-Powered Drill

Following exhaustive tests on actual drilling operations conducted on all types of jobs and under a wide variety of working conditions, the Barco Manufacturing Co., 1801 Winnemac Ave., Chicago, Ill., announce full time production on their newly designed, self-powered, portable driller known as the "Barco J-2". The former drilling equipment manufactured by the Barco Manufacturing Co. consisted of a drilling swivel applied as an

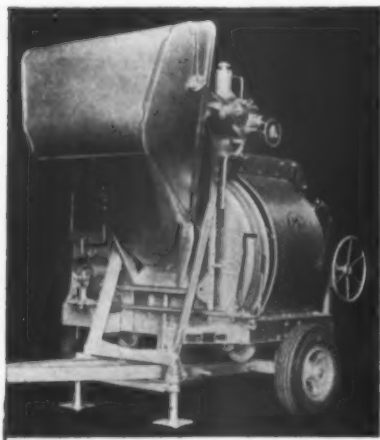


*New J-2 at Work on a Quarry Job with the Drill Hole Blowing Equipment Also in Use*

accessory tool to the Barco Hammer, but the J-2 is designed as a driller, pure and simple, incorporating the drill-turning mechanism directly in the base of the power unit. Thus it is able to strike a full, direct blow, delivering all its power at the drill head. A ratchet wrench for turning the drill rod is standard equipment with the J-2, and, if the user desires to eliminate hand spooning or flushing of the hole, a small portable air compressor unit, necessary storage tank and fittings, is available.

### New 14S Mixers

Two new 14S mixers have been added to the line of the Construction Machinery Co., Waterloo, Ia. These new models, with the popular lighter weight CMC 14S End Discharger introduced several years



*CMC 14S—Two-Wheeler*

ago, now give the company the three types: CMC 14S 2-wheel end discharger; CMC 14S 4-wheel side discharger; CMC 14S 4-wheel end discharger. The manufacturers emphasize the use of recently developed special manganese steel and other alloys in these machines which effect weight reductions without sacrificing long life or sturdiness. The first 14S of this type was highly popular with the bridge and culvert builder; these other models bring the same mixing speed and savings.

### New Heavy-Duty Diesel Engine-Driven Compressor

A new heavy-duty Diesel-engine-driven compressor, known as the "XVO," has just been announced by the Ingersoll-Rand Co., 11 Broadway, New York.

This machine is stated to be suitable for use wherever economy is a primary consideration, in independent or isolated compressor plants, or when existing power facilities are overloaded. It is recommended for use in mines and quarries, construction and contracting, drill barges, ice and cold storage plants, air-lift and pumping and general industrial service. The "XVO" is entirely new in design and combines a horizontal heavy-duty double-acting compressor with a heavy-duty "V" type four-cycle Diesel engine in a single compact and comparatively light-weight unit which operates at a moderate speed.

Sizes are available for actual-free air delivery ratings of 625, 935, and 1250 c.f.m. for 100-lb. sea-level compression. In addition, a wide variety of air, gas, and ammonia compressing cylinders is available for pressures ranging from vacuum to 5000-lb. per square inch and higher.

### New Trucks

The complete line of trucks for 1939, announced by the Federal Motor Truck Co., Detroit, Mich., includes several models which make their maiden appearance this year. These models are of the super heavy duty type, ranging in capacity from 6 to 8 tons. In addition there will be the line of lighter models from ¾ to 5 ton capacity, another group of heavy duty models from 4 to 7½ tons in size, and a group of cab-over-engine trucks carrying ratings of 1½ to 5 tons. Completing the line are ten 6-wheel models in conventional and cab-over-engine types from 4 to 8 tons capacity. Models 62 and 65 weighing 10,400 and 11,300 lb. respectively, are powered with a Continental 22R 6 cylinder valve-in-head engine of 4½ in. bore by 5½ in. stroke developing 138 H.P. The general specifications of the 63 and 66 models are the same as the 62 and 65 with the exception of the engine which is a 6SRK Waukesha 6 cylinder, 7-bearing L-head type of 4½ in. bore by 5½ in. stroke, developing 115 H.P. Trucks of the smaller sizes, in conventional and cab-over-engine types, from ¾ to 5 ton capacity are all powered with 6 cylinder Hercules engines, designed especially for truck service. All of these engines have 2½ in. 7-bearing crankshafts with "Tocco" electrically hardened bearing surfaces, removable cadmium bearings, full length water jackets, gear driven water pumps and silent helical timing gears.

### Buda-Lanova Diesel Engine for Ford Trucks

The Buda Company, Harvey, Ill., pioneer manufacturers of light-weight, high-speed diesel engines for trucks and buses, have announced one of their standard production models for installation in Ford truck chassis. The engine used is a 4-cycle, 4-cylinder solid injection Buda-Lanova Diesel, Model 4-DT-212, with 3½ in. bore by 5½ in. stroke, having a 212 cu. in. displacement. This model, like all of the other 9 models of Buda Diesel truck and bus engines, incorporates the Lanova combustion system. This system is called "controlled turbulence," which provides low maximum cylinder pressure, high "workable" mean effective pressure and superior starting characteristics in cold weather. Other features of this sturdy engine are removable dry sleeves, replaceable precision bearings, aluminum alloy pistons, and force feed lubrication throughout. The Buda Company also announces that they have a 6 cylinder diesel now available for cab over engine Ford chassis.

### WITH THE MANUFACTURERS

#### "Caterpillar" Treasurer Named Sales Chief

Donald A. Robinson, heretofore treasurer of an R&S company, has been appointed general sales manager of the Caterpillar Tractor Co., Peoria, Ill. W. J. McBrien, Domestic Credit Manager, has been promoted to head of the treasury department. Mr. Robinson's rise at "Caterpillar" has been a steady and a rapid one. He joined the company's western division at San Leandro, Calif., in 1926, and was assigned manual labor in the parts store room. From the factory he went into the parts department office the following year, and then to the credit department as a clerk. He was lent to the sales department on special assignment, then returned to be promoted to assistant credit manager, to cashier and then to credit manager of the western division. Coming to the Peoria offices in 1930, Mr. Robinson again won promotion three years later as assistant treasurer, and in 1937 was elevated to treasurer, a position he has ably filled until the present time. Mr. Robinson was born in Reno, Nev., but at an early age moved with his parents to Sparks, Nev., where he received his grade and high school education. During the latter and his four years at the University of Nevada, he worked as a car checker for the Southern Pacific railroad. After 3½ years of study for the degree of mechanical engineer, the young man made a decision that was



*D. A. Robinson*

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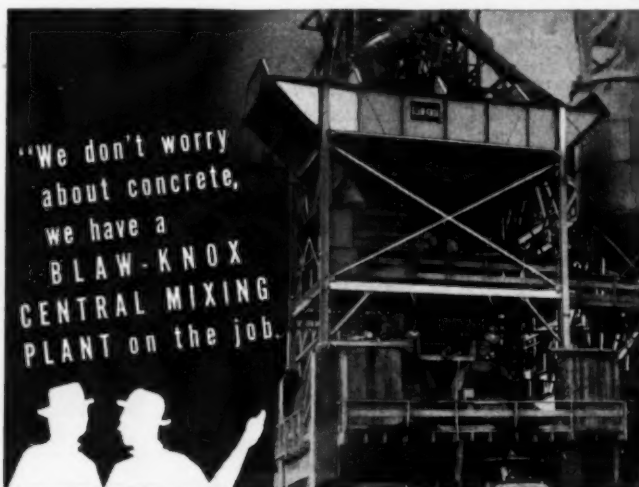
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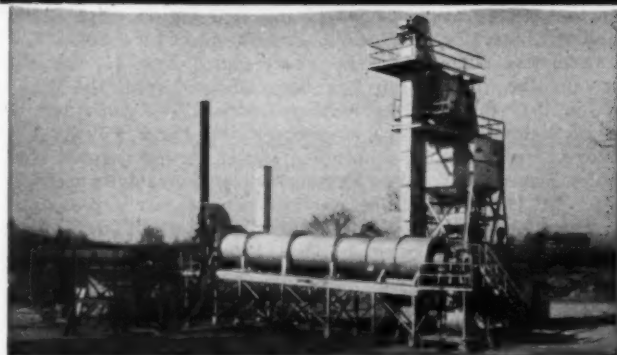
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greatly to affect his business life. He decided to major in business administration, studied diligently to obtain the added credits, and was graduated with a business degree. "It really wasn't my decision, though," Mr. Robison recalled. "My prof did that. He said I was more suited for business, and that if I didn't transfer, he'd flunk me." Almost immediately after graduation, Mr. Robison obtained work at "Caterpillar". On Oct. 11, 1926, he and Miss Ruth Moore were married. The couple has two children, Ardis and Darrell. Mr. Robison is a member of Sigma Nu fraternity, the National Association of Credit Men and is President of the Board of School Inspectors at Peoria. Mr. McBrien is a native Illinoisan, born at Mount Vernon. He was graduated from the University of Indiana in 1921, and that same year went to work for the Evansville (Ind.) Journal, as a cub reporter. Within three years he became city editor of the newspaper. He left the Journal in 1923, and a year later joined Standard Oil Company of Indiana at Evansville. He became assistant office manager there and later was transferred to Detroit, where he remained until 1927. He came to Peoria as office manager for a new branch office of the oil company. December 22, 1928, he left Standard Oil to become domestic credit manager for Caterpillar Tractor Co. In 1930, he became manager of the company's order bureau, going from that position to foreign credit manager. Later he was transferred back to the domestic credit division. He married Mildred Marie Schulte of Evansville in 1918. He has one son, James W., now attending the University of Virginia.

#### Moses and Aldridge Join Brooks Equipment

Everett Moses, formerly manager Eastern Division, Dempster Brothers, Inc., has been appointed as Northeastern representative for the Brooks Equipment & Mfg. Co., of Knoxville, Tenn., effective Oct. 15th. Mr. Moses will take on the line of Day Jaw Type Rock Crushers and "swing hammer" crushers, manufactured by the Brooks company. G. V. Aldridge, formerly in the Sales Department of The Hug Company, manufacturers of the Hug Truck, joined the Brooks Equipment & Mfg. Co., of Knoxville, Tenn., as of Nov. 1, 1938. Mr. Aldridge will specialize in the sales of the "Brooks Load Lugger" in the Southwest and on the West Coast where he is already well known among the equipment distributors and contractors.

#### Hercules Powder Names Tom Brown Manager Contractors Division

Hercules Powder Co., Wilmington, Del., has announced the appointment of Tom Brown as manager of the contractors' division of the explosives department, succeeding J. J. Kelleher, who resigned Nov. 11. Mr. Brown, connected with the explosives industry since 1911, is widely known to the contractors of this country.

Tom Brown became affiliated with Hercules Powder Co. in 1929. After a year of sales work in Birmingham, Ala., district, he went to Chicago where for the past eight years he has served as a representative of the contractors' division. Promotion to manager of the division follows a successful record of sales activities which have given him an intimate knowledge of contractors' requirements. Mr. Brown will make his headquarters in Wilmington.

#### E. R. Galvin Becomes General Sales Manager for LeTourneau

E. R. ("Ed") Galvin, well-known executive and former general sales manager of the Caterpillar Tractor Co., has accepted a similar position with R. G. Le-

eral sales manager, directing their world-wide sales organization. One of Galvin's seven children, Robert, has been employed by R. G. LeTourneau, Inc., for two years in the capacity of serviceman.

#### Quinton Appointed Director of Sales for Hanson

The Hanson Excavator Works, division of the Hanson Clutch & Machinery Co., Tiffin, O., manufacturers of excavators including cranes, shovels, draglines and clamshells of the crawler and truck-mounted types, ranging in sizes of  $\frac{3}{8}$ ,  $\frac{1}{2}$ , and  $\frac{3}{4}$  cu. yd. capacities; manufacturers of heavy-duty low platform gooseneck trailers and semi-trailers as well as skeleton trailers,



E. R. Galvin (left) and D. M. Burgess

Tourneau, Inc., of Peoria, Ill., manufacturers of heavy grading equipment. He assumed his new duties Oct. 31, 1938. Because LeTourneau business for the past five years has increased more than 1400 per cent and promises to continue the upward trend due to the new equipment developments and the resulting new markets, it was felt that a man of Mr. Galvin's caliber was needed to coordinate all sales efforts. Thus, when Denn M. Burgess, Domestic Sales Manager, was promoted to general manager of the LeTourneau organization, Mr. Galvin was sought for sales manager. His world-wide knowledge of earthmoving needs and dealer good-will throughout the industry are expected to be invaluable assets. Born in 1884 in Ontario, Canada, his parents moved to the United States when he was 8 years old to follow the lure of the great White Pine lumber industry. His early public school education in Michigan and Wisconsin was followed by a business course in Duluth, Minn. In 1906, he entered the employ of DuPont, working in the office. Later, he went out as one of their explosive demonstrators, only to return to the main office in Wilmington, Del., in 1919 to fill a position as a Director of Sales. Mr. Galvin left DuPont in 1925 to enter the tractor field as general sales manager of the Cleveland Tractor Co. In 1927, he joined the Caterpillar organization travelling for them as a general representative. Shortly afterwards, he was advanced to eastern sales manager, and a year and a half ago became Caterpillar's first gen-

eral sales manager, directing their world-wide sales organization. One of Galvin's seven children, Robert, has been employed by R. G. LeTourneau, Inc., for two years in the capacity of serviceman.

#### J. Rex St. Clair Named Manager of Wilmington Office of Hercules Powder Company

Hercules Powder Company announces the appointment of J. Rex St. Clair as manager of the Wilmington office of the explosives department, succeeding J. J. Kelleher, who resigned Nov. 11. Mr. St. Clair has been affiliated with the explosives industry since 1918, when he became a salesman for Aetna Powder Co., at Ishpeming, Mich. He later served Hercules Powder Co. in the same capacity in Minnesota iron-mining territory. After considerable service at Duluth, Minn., Wilmington, Del., Pittsburgh, Pa., and Joplin, Mo., he was placed in charge of New York State and New Jersey sales, under the Wilmington Branch Office.

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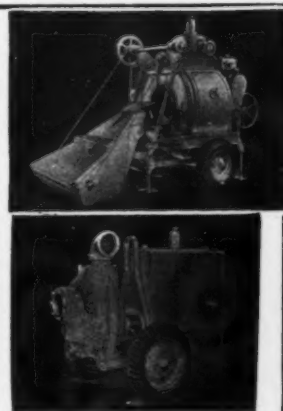
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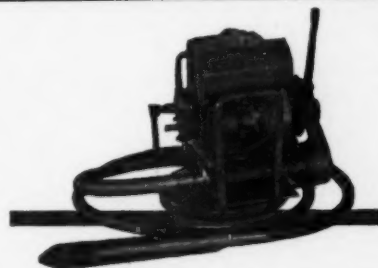
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